Southwest District • Hillsborough River Basin

Draft Report

Nutrient TMDLs for Lake Thonotosassa (WBID 1522B) and Flint Creek (WBID 1522A)

and Documentation in Support of the Development of Site-Specific Numeric Interpretations of the Narrative Nutrient Criterion

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Executive Summary

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairments of Lake Thonotosassa and Flint Creek, located in the Hillsborough River Basin. The waterbodies were verified as impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.), and were included on the Cycle 3 Verified List of Impaired Waters for the Tampa Bay Tributaries Basin Group adopted by Secretarial Order in April 2016. Lake Thonotosassa (the segment with waterbody identification [WBID] number 1522B), located in west-central Florida, covers an area of 850 acres and is the largest natural lake in Hillsborough County. The lake is 1.6 miles long and 0.85 miles wide, with an average water depth of 10.5 feet and a watershed drainage area of over 56 square miles. Flint Creek (WBID 1522A), the outlet channel for the lake, is 3.0 miles long and flows to the Hillsborough River.

Lake Thonotosassa was originally verified as impaired for nutrients during the Cycle 1 assessment for the Hillsborough River Basin based on elevated Trophic State Index (TSI) values and was included on the Verified List of Impaired Waters. The Cycle 1 Verified List also included Flint Creek (WBID 1522A), which was impaired for nutrients based on elevated chlorophyll *a* levels.

For the most recent Cycle 3 assessment period, Lake Thonotosassa was verified impaired for nutrients based on exceedances of adopted numeric nutrient criteria for chlorophyll *a*, total nitrogen (TN), and total phosphorus (TP) that went into effect on October 27, 2014. The Flint Creek segment was included on the Cycle 3 Verified List for chlorophyll *a*.

Total maximum daily loads (TMDLs) for TN and TP have been developed for Lake Thonotosassa and Flint Creek. **Table EX-1** contains supporting information for the TMDLs. These TMDLs were developed in accordance with Section 303(d) of the federal Clean Water Act and guidance developed by the U.S. Environmental Protection Agency.

Table EX-1. Summary of TMDL supporting information for Lake Thonotosassa and Flint Creek

Type of Information	Description
Waterbody name (WBID)	Lake Thonotosassa (WBID 1522B), Flint Creek (WBID 1522A)
Hydrologic Unit Code 8	03100205
Use classification/ Waterbody designation	Class III Freshwaters
Targeted beneficial uses	Fish consumption; recreation; and propagation and maintenance of a healthy, well-balanced population of fish and wildlife
303(d) listing status	Verified List of Impaired Waters for the Group 2 basins (Tampa Bay Tributaries Basin Group) adopted via Secretarial Order dated May 27, 2004
TMDL pollutants	TN and TP
TMDLs and site-specific interpretations of the narrative nutrient criterion	**Lake Thonotosassa (WBID 1522B):** **Chlorophyll *a*:** 32 micrograms per liter (µg/L), expressed as an annual geometric mean (AGM) concentration not to be exceeded more than once in any consecutive 3-year period. **TN:** 46,962 pounds per year (lbs/yr), expressed as a 7-year average of annual loads not to be exceeded. **TP:** 3,137 lbs/yr, expressed as a 7-year average of annual loads not to be exceeded. **Flint Creek (WBID 1522A):** **Chlorophyll a:** 12 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. **TN:** 1.78 milligrams per liter (mg/L), expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. **TP:** 0.20 mg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.
Load reductions required to meet the TMDLs	**WBID 1522B**: 29 % TN reduction and 89 % TP reduction to achieve a chlorophyll *a* target of 32 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period. **WBID 1522A**: 29 % TN reduction and 89 % TP reduction to achieve a chlorophyll *a* target of 12 µg/L, expressed as an AGM concentration not to be exceeded more than once in any consecutive 3-year period.
Concentration-based lake restoration targets	**WBID 1522B:** The nutrient concentrations corresponding to the chlorophyll *a* criterion and the loading-based criteria are a TN AGM of 1.64 mg/L and a TP AGM of 0.08 mg/L, not to be exceeded more than once in any consecutive 3-year period.

Acknowledgments

This analysis was accomplished thanks to significant contributions from staff in the Florida Department of Environmental Protection (DEP) Division of Environmental Assessment and Restoration, specifically, the Office of Watershed Services, Watershed Assessment Section, Standards Development Section, Water Quality Restoration Program, Southwest Regional Operations Center, and Watershed Evaluation and TMDL Section. DEP also recognizes the Southwest Florida Water Management District and Hillsborough County for their contributions towards understanding the issues, history, and processes at work in the Lake Thonotosassa Watershed.

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Chapter 1: Introduction

1.1 Purpose of Report

This report presents the total maximum daily loads (TMDLs) developed to address the nutrient impairments of Lake Thonotosassa and Flint Creek, located in the Hillsborough River Basin. The TMDLs will also constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), Florida Administrative Code (F.A.C.), that will replace the otherwise applicable numeric nutrient criteria (NNC) in Subsection 62-302.531(2), F.A.C., for these particular waterbodies, pursuant to Paragraph 62-302.531(2)(a), F.A.C. The waterbodies were verified as impaired for nutrients using the methodology in the Identification of Impaired Surface Waters Rule (IWR) (Chapter 62-303, F.A.C.), and were included on the Verified List of Impaired Waters for the Tampa Bay Tributaries Basin Group adopted by Secretarial Order in April 2016.

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and provides water quality targets needed to achieve compliance with applicable water quality criteria based on the relationship between pollutant sources and water quality in the receiving waterbody. The TMDLs establish the allowable loadings to Lake Thonotosassa and Flint Creek that would restore the waterbodies so that they meet their applicable water quality criteria for nutrients.

1.2 Identification of Waterbodies

For assessment purposes, the Florida Department of Environmental Protection (DEP) divided the Hillsborough River Basin (Hydrologic Unit Code [HUC] 03100205) into watershed assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or surface water segment. Lake Thonotosassa is WBID 1522B and Flint Creek is WBID 1522A. **Figure 1.1** shows the location of the WBIDs in the basin and major geopolitical and hydrologic features in the region, and **Figure 1.2** contains a more detailed map of the WBID areas.

Lake Thonotosassa and Flint Creek are located in Hillsborough County 13 miles northeast of the center of Tampa. Lake Thonotosassa is the largest natural lake in the county, with a surface area of 850 acres (1.3 square miles), and is 1.6 miles long and 0.85 miles wide, with an average water depth of 10.5 feet (3.2 meters). Baker Creek, the main tributary of the lake, enters the lake on the south end. The lake watershed area includes portions of the City of Plant City, located east of the lake, and Valrico, a Census-designated place, located in the southern area of the basin (**Figure 1.2**).

Lake Thonotosassa flows into Flint Creek through an outfall structure on the northeast side of the lake. Flint Creek is 3.0 miles in length and flows in a northerly direction into a forested wetland area along the Hillsborough River. Campbell Branch, a tributary to Flint Creek, flows into the creek 0.3 miles downstream of the lake outlet (**Figure 1.2**).

1.3 Watershed Information

1.3.1 Population and Geopolitical Setting

The Lake Thonotosassa Watershed encompasses an area of 36,100 acres (56.4 square miles). Urban land covers more than half of the watershed, with the greatest level of development located in the areas of Plant City, in the eastern part of the drainage area, and Valrico, in the southern portion of the watershed. About 20 % of the watershed consists of agricultural land, the majority being pastureland and row crops. Interstate 4, which connects Tampa and Orlando, lies in the northern area of the watershed.

The Flint Creek Watershed below the lake has a more rural landscape, where low-density residential and agriculture are the dominant land uses, covering three-quarters of the drainage area.

1.3.2 Topography

The highest elevations, of 150 feet, occur in the eastern portion of the watershed near Plant City. This area is drained by Mill Creek and Spartman Branch, tributaries of Pemberton Creek, which flows in a westerly direction into Baker Creek. Elevations on Baker Creek where it enters Lake Thonotosassa are less than 40 feet. The Seffner Canal drains the southern portion of the watershed where the highest elevations exceed 100 feet in the area south of State Road (SR) 60. The canal flows north into Baker Creek, 1 mile upstream of the lake (**Figure 1.2**).

1.3.3 Hydrogeological Setting

The greater hydrogeological context in which the lake functions is determined in part by the topography, but also by soil geology, aquifer/groundwater interactions, and climate.

Soils are classified by the National Cooperative Soil Survey into four hydrologic soil groups (HSGs)—Types A, B, C, and D—based on their runoff potential. "A" type soils are typically well-drained, have deep water tables, and consist of sandy textured soils with relatively low runoff potential. "B" type soils are typically loamy with some silt component, a moderately coarse texture, and a lower infiltration rate than Type A soils and are moderately well-drained. "C" type soils are sand, clay, and loam with more fine textures and lower infiltration rates, especially when wet. "D" type soils are variable in texture but generally have a greater clay component and are often found at lower topography with higher water tables that generate higher amounts of runoff. Multiclassed soils vary in their hydrologic response depending on in situ drainage improvements.

Figure 1.3 shows the distribution of soil types in the Lake Thonotosassa Watershed and the Flint Creek Watershed downstream of the lake. The majority of the lake watershed consists of a mix of well-drained soils ("A" soils covering more than 50 % of the area) and variable soil with greater clay content ("A/D" soils making up one-third of the area) (**Table 1.1**). In the Flint Creek Watershed below the lake, Type A/D soils comprise over 50 % of the area, followed by Type A soils, which comprise over 20 % of the area (**Table 1.1**).

Lake Thonotosassa is in the Hillsborough Valley lake region, a plain of low-relief containing relatively sluggish surface drainage of the Hillsborough River Watershed (Griffith et al. 1997). The eastern and southern areas of the lake's watershed are located in the Lakeland/Bone Valley Upland lake region, which is covered by phosphatic sand or clayey sand from the Miocene-Pliocene Bone Valley Member of the Peace River Formation in the Hawthorn Group, where phosphorus-rich geologic deposits occur (Griffith et al. 1997).

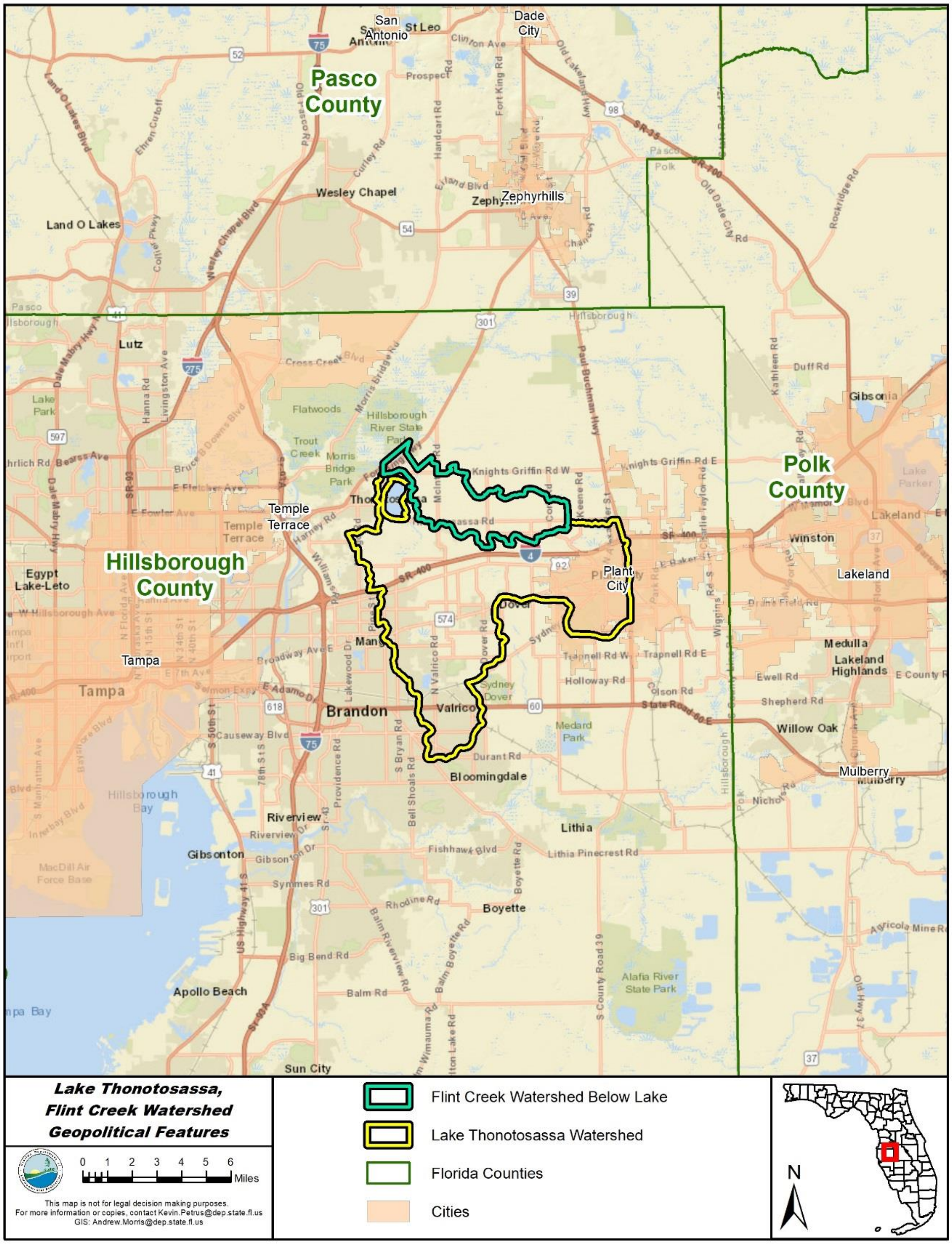

Figure 1.1. Location of the Lake Thonotosassa (WBID 1522B) and Flint Creek (WBID 1522A) Watersheds in Hillsborough County and major hydrologic and geopolitical features in the area

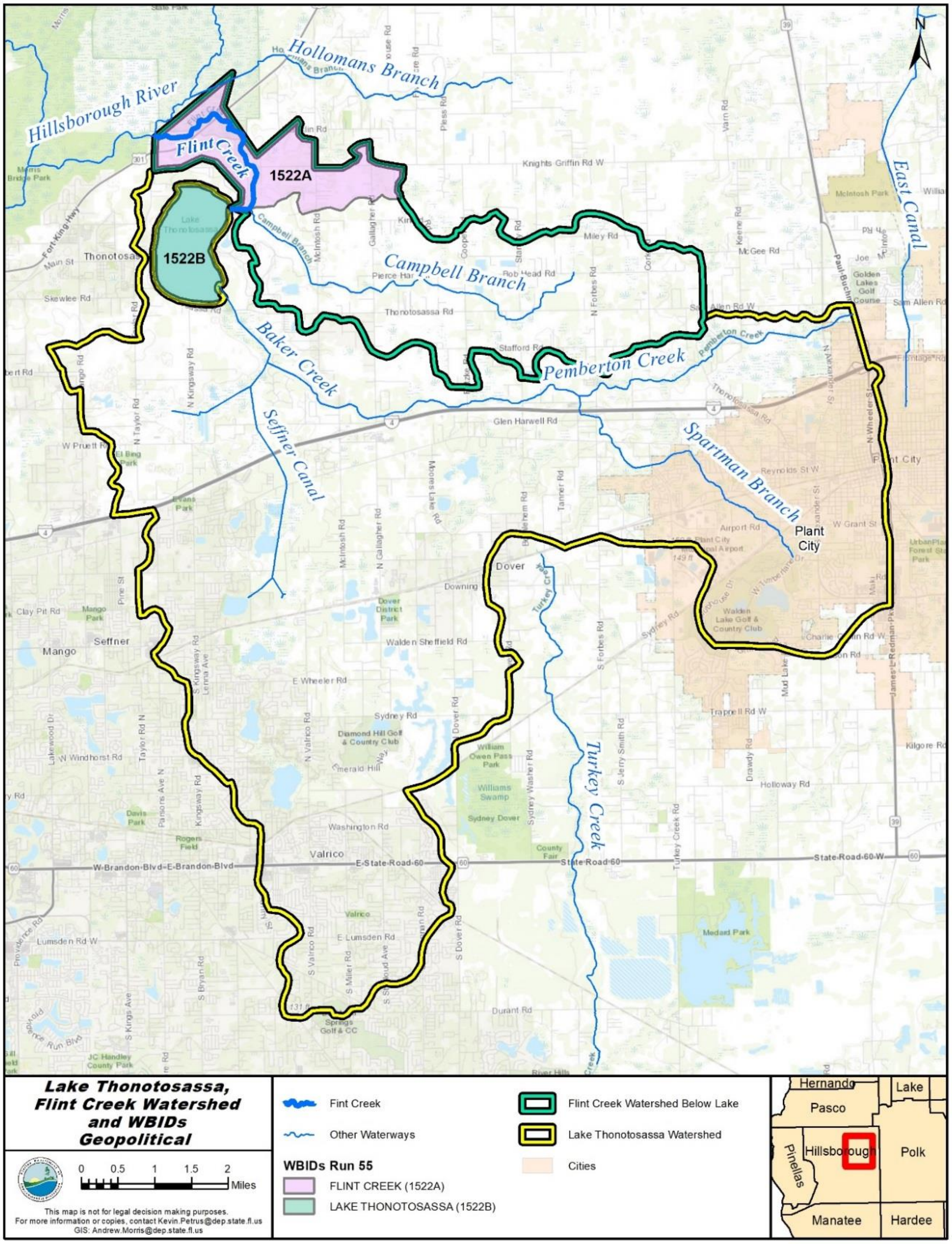

Figure 1.2. Lake Thonotosassa (WBID 1522B) and Flint Creek (WBID 1522A) segments and watershed areas

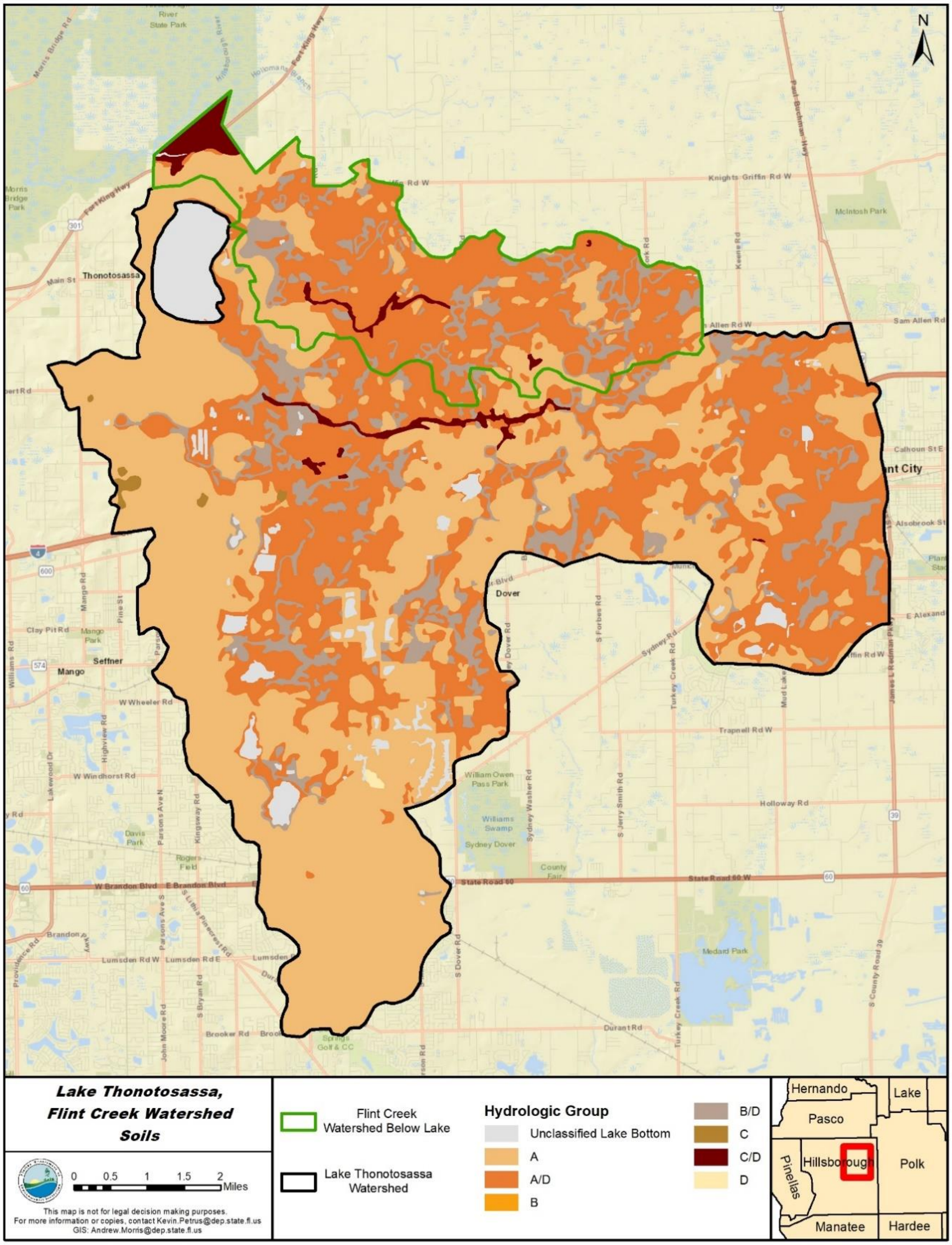

Figure 1.3. Hydrologic soil groups in the Lake Thonotosassa Watershed and Flint Creek Watershed below the lake

Table 1.1. Soil type acreage in the Lake Thonototosassa Watershed and Flint Creek Watershed below the lake

N/A = Not applicable because the area is unclassified lake bottom. Hybrid soil types are A/D, B/D, and C/D.

Soil	Lake Thonotosassa Watershed (Acres)	Lake Thonotosassa Watershed (%)	Flint Creek Watershed Below Lake (Acres)	Flint Creek Watershed Below Lake (%)
Unclassified Lake Bottom	937	2.59	16	0.18
A	19,349	53.58	1,848	21.99
A/D	12,121	33.56	4,843	57.62
B/D	3,331	9.22	1,273	15.15
C	91	0.25	0	0.00
C/D	260	0.72	425	5.05
D	27	0.07	0	0.00

Chapter 2: Water Quality Assessment and Identification of Pollutants of Concern

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act (CWA) requires states to submit to the U.S. Environmental Protection Agency (EPA) lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. DEP has developed such lists, commonly referred to as 303(d) lists, since 1992.

The Florida Watershed Restoration Act (FWRA) (Section 403.067, Florida Statutes [F.S.]) directed DEP to develop, and adopt by rule, a science-based methodology to identify impaired waters. The Environmental Regulation Commission adopted the methodology as Chapter 62-303, F.A.C. (the IWR), in 2001. The rule was amended in 2006, 2007, 2012, 2013, and 2016.

The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], F.S.). The state's 303(d) list is amended annually to include basin updates.

2.2 Classification of the Waterbody and Applicable Water Quality Standards

Lake Thonotosassa and Flint Creek are Class III (fresh) waterbodies, with a designated use of fish consumption, recreation, and propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The Class III water quality criterion applicable to the verified impairment (nutrients) for the waterbodies is Florida's nutrient criterion in Paragraph 62-302.530(48)(b), F.A.C. Florida adopted NNC for lakes, spring vents, and streams in 2011. These were approved by the EPA in 2012 and became effective in 2014.

The applicable lake NNC are dependent on alkalinity, measured in milligrams per liter as calcium carbonate (mg/L $CaCO_3$) and true color (color), measured in platinum cobalt units (PCU), based on long-term period of record (POR) geometric means (**Table 2.1**). The Lake Thonotosassa POR alkalinity geometric mean is 59 mg/L $CaCO_3$ (n = 161) and the color geometric mean is 50 PCU (n = 1,155). The geometric means were calculated based on the results in the IWR Database Run 55. Using this methodology, Lake Thonotosassa is classified as a high-color (>40 PCU) lake.

The chlorophyll *a* NNC for high-color lakes is an annual geometric mean (AGM) value of 20 micrograms per liter (µg/L), not to be exceeded more than once in any consecutive 3-year period. The associated total nitrogen (TN) and total phosphorus (TP) criteria for a lake can vary annually, depending on the availability of data for chlorophyll *a* and the concentrations of chlorophyll *a* in the lake. If there are sufficient data to calculate an AGM for chlorophyll *a* and the mean does not exceed the chlorophyll *a* criterion for the lake type listed in **Table 2.1**, then the TN and TP numeric interpretations for that calendar year are the AGMs of lake TN and TP samples, subject to the minimum and maximum TN and TP limits in the table. If there are insufficient data to calculate the AGM for chlorophyll *a* for a given year, or the AGM for chlorophyll *a* exceeds the values in the table for the lake type, then the applicable numeric interpretations for TN and TP are the minimum values in the table. **Table 2.1** lists the NNC for Florida lakes specified in Subparagraph 62-302.531(2)(b)1., F.A.C.

Table 2.1. Chlorophyll *a*, TN, and TP criteria for Florida lakes (Subparagraph 62-302.531[2][b]1., F.A.C.)

* For lakes with color > 40 PCU in the West Central Nutrient Watershed Region, the maximum TP limit is the 0.49 mg/L TP streams threshold for the region.

Long-Term Geometric Mean Lake Color and Alkalinity	AGM Chlorophyll *a* (µg/L)	Minimum Calculated AGM TP NNC (mg/L)	Minimum Calculated AGM TN NNC (mg/L)	Maximum Calculated AGM TP NNC (mg/L)	Maximum Calculated AGM TN NNC (mg/L)
>40 PCU	20	0.05	1.27	0.16*	2.23
≤ 40 PCU and > 20 mg/L $CaCO_3$	20	0.03	1.05	0.09	1.91
≤ 40 PCU and ≤ 20 mg/L $CaCO_3$	6	0.01	0.51	0.03	0.93

The nutrient standard for streams in Paragraph 62-302.531(2)(c), F.A.C., states:

> (c) For streams, if a site specific interpretation pursuant to paragraph 62-302.531(2)(a) or (2)(b), F.A.C., has not been established, biological information shall be used to interpret the narrative nutrient criterion in combination with Nutrient Thresholds. The narrative nutrient criterion in paragraph 62-302.530(48)(b), F.A.C., shall be interpreted as being achieved in a stream segment where information on chlorophyll *a* levels, algal mats or blooms, nuisance macrophyte growth, and changes in algal species composition indicates there are no imbalances in flora or fauna, and either:
>
> 1. The average score of at least two temporally independent SCIs [Stream Condition Index assessments] performed at representative locations and times is 40 or higher, with neither of the two most recent SCI scores less than 35, or
>
> 2. The nutrient thresholds set forth in the table below (see **Table 2.2**) are achieved.

Since Flint Creek is in the West Central nutrient region, the generally applicable TN and TP thresholds are 1.65 and 0.49 mg/L, respectively, expressed as not to be exceeded more than once in any 3-year period. These nutrient thresholds are part of the numeric nutrient standards for streams, which also includes floral and faunal metrics. According to the NNC Implementation Document, streams with AGM chlorophyll *a* levels below 3.2 µg/L attain the chlorophyll *a* metric, while streams with AGM chlorophyll *a* levels above 20 are impaired. Streams with chlorophyll *a* levels between 3.2 and 20 µg/L should be compared with reference streams in the area. According to Rule 62-303.450(1), F.A.C., a stream without applicable numeric criteria in Subsection 62-302.531(2), F.A.C., shall be placed on the Verified List if AGM chlorophyll *a* concentrations exceed 20 µg/L more than once in a 3-year period.

Table 2.2. TN and TP criteria for Florida streams (Subparagraph 62-302.531[2][c]2., F.A.C.)

[1]These values are AGM concentrations not to be exceeded more than once in any three calendar years.

Nutrient Watershed Region	TP Nutrient Threshold (mg/L)[1]	TN Nutrient Threshold (mg/L)[1]
Panhandle West	0.06	0.67
Panhandle East	0.18	1.03
North Central	0.30	1.87
Peninsular	0.12	1.54
West Central	0.49	1.65
South Florida	No numeric nutrient threshold. The narrative criterion in Paragraph 62-302.530(48)(b), F.A.C., applies.	No numeric nutrient threshold. The narrative criterion in Paragraph 62-302.530(48)(b), F.A.C., applies.

2.3 Determination of the Pollutant of Concern

2.3.1 Data Providers

The sources of nutrient data for Lake Thonotosassa are stations sampled by the Hillsborough County Environmental Protection Commission (21FLHILL…), the Southwest Florida Water Management District (SWFWMD) (21FLSWFD…), and DEP's Southwest District (21FLTPA…). The sources of nutrient data for Flint Creek are stations sampled by Hillsborough County (21FLHILL…) and DEP's Southwest District (21FLTPA…). The majority of available nutrient data for the lake and creek come from the monitoring by Hillsborough County, performed approximately monthly. The county has sampled near the lake center (Station 135) and near the lake outlet (Station 118) since the mid-1970s. The county has monitored the creek at U.S. Highway 301 since 1989 (Station 148). The other sampling organizations conduct monitoring intermittently. **Figure 2.1** shows the sampling locations in Lake Thonotosassa and Flint Creek.

Data collected by Hillsborough County, SWFWMD, and DEP were used for lake model calibration for TMDL development and are discussed in detail in **Chapter 5**.

The individual water quality measurements used for this report are available in IWR Database Run 55 and are available on request.

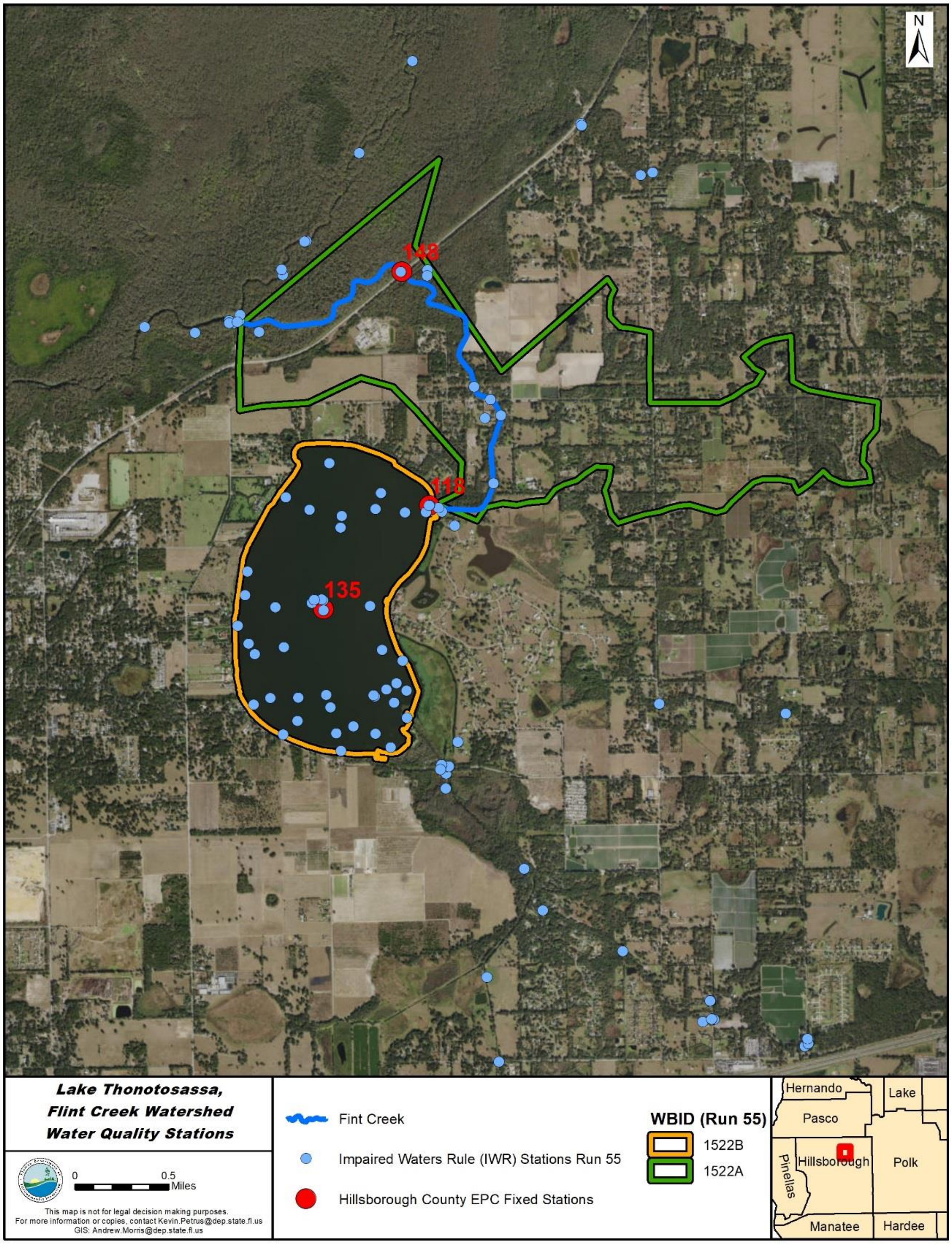

Figure 2.1. Monitoring stations in Lake Thonotosassa and Flint Creek

2.3.2 Information on Verified Impairment

DEP used the IWR methodology to assess water quality in Lake Thonotosassa and Flint Creek, and both the lake and creek were verified as impaired for nutrients during the Cycle 1 verified period (the verified period for the Tampa Bay Tributaries Group 2 Basin was January 1, 1996, to June 30, 2003). At the time the Cycle 1 assessment was performed, the IWR methodology used TN, TP, and chlorophyll *a* (a measure of algal mass) in calculating annual TSI values to assess lakes and in interpreting Florida's narrative nutrient threshold. The TSI impairment threshold (60 for lakes with color higher than 40 PCU) was exceeded in Lake Thonotosassa in multiple years during the Cycle 1 verified period, and these exceedances were sufficient to identify the lake as impaired for nutrients. Exceeding a TSI of 60 in any one year of the verified period was sufficient for identifying a lake as impaired for nutrients.

When the Cycle 1 assessment was performed, streams were assessed for nutrient impairment by determining if annual mean chlorophyll *a* values exceeded the threshold of 20 µg/L in any year of the assessment period. Flint Creek was listed for nutrient impairment because annual mean chlorophyll *a* values exceeded the stream threshold of 20 µg/L in multiple years during the Cycle 1 verified period.

On July 2, 2012, the IWR was amended to incorporate the numeric interpretations of Florida's narrative nutrient criterion (Rule 62-302.531, F.A.C.). Under the revised IWR methodology, lakes are assessed for chlorophyll *a*, TN, and TP as individual parameters, and the TSI is no longer used. In Cycle 3, the IWR methodology used the new lake NNC (**Table 2.1**).

The Cycle 3 assessment (verified period January 1, 2007, to June 30, 2014) incorporated changes in Chapters 62-302 and 62-303, F.A.C., for NNC. Lake Thonotosassa was delisted for nutrients based on the TSI, since this index was no longer used to assess nutrient impairment. Using the NNC for high-color lakes, Lake Thonotosassa was placed on the Verified List for chlorophyll *a*, TN, and TP, because the AGMs for the three variables exceeded the nutrient criteria more than once in a three-year period during the verified period. **Table 2.3** presents the lake AGMs for all three variables during the 2000–16 period.

As part of the nutrient assessment for streams under the revised IWR methodology, the chlorophyll *a* AGMs are compared with the nutrient impairment threshold of 20 µg/L to determine if the AGMs exceed the threshold more than once in a 3-year period. **Table 2.4** lists the Flint Creek AGMs during the 2000–16 period. The creek was verified impaired for nutrients based on AGM chlorophyll *a* concentrations that exceeded the stream threshold more than once in a 3-year period during the verified period.

Table 2.3. Lake Thonotosassa AGM values, 2000–16

Note: Values shown in boldface type and shaded are greater than the NNC for high-color lakes. Rule 62-302.531, F.A.C., states that the applicable numeric interpretations for TN, TP, and chlorophyll *a* shall not be exceeded more than once in any consecutive three-year period.

Year	*Chlorophyll a (µg/L)*	*TN (mg/L)*	*TP (mg/L)*
2000	**177**	**3.63**	**0.34**
2001	**129**	**3.27**	**0.26**
2002	**105**	**2.54**	**0.23**
2003	**147**	**2.21**	**0.39**
2004	**147**	**2.49**	**0.52**
2005	**75**	**2.04**	**0.34**
2006	**100**	**2.08**	**0.33**
2007	**130**	**2.78**	**0.25**
2008	**144**	**2.35**	**0.19**
2009	**124**	**1.91**	**0.17**
2010	**111**	**2.24**	**0.27**
2011	**162**	**3.12**	**0.25**
2012	**115**	**2.74**	**0.27**
2013	**124**	**2.46**	**0.29**
2014	**102**	**1.97**	**0.23**
2015	**78**	**1.61**	**0.32**
2016	**97**	**2.14**	**0.44**

Table 2.4. Flint Creek AGM values, 2000–16

Note: Values shown in boldface type and shaded are greater than the applicable NNC thresholds for streams. Rule 62-302.531, F.A.C., states that the applicable numeric interpretations for TN, TP, and chlorophyll *a* shall not be exceeded more than once in any consecutive three-year period.

Year	**Chlorophyll *a* (µg/L)**	**TN (mg/L)**	**TP (mg/L)**
2000	**51**	**3.04**	**0.68**
2001	**40**	**1.82**	0.38
2002	**89**	**2.04**	0.28
2003	**56**	**1.84**	0.39
2004	**60**	1.65	0.42
2005	**23**	**2.00**	0.35
2006	**45**	**2.04**	0.37
2007	**69**	**2.35**	0.29
2008	**81**	**2.49**	0.32
2009	**51**	**1.76**	0.25
2010	**62**	**1.84**	0.30
2011	**94**	**2.76**	0.31
2012	**64**	**2.48**	0.39
2013	**71**	**2.01**	0.32
2014	**70**	**1.69**	0.26
2015	**37**	1.60	0.39
2016	**55**	**2.02**	**0.52**

Chapter 3: Site-Specific Numeric Interpretation of the Narrative Nutrient Criterion

3.1 Establishing the Site-Specific Interpretation

The nutrient TMDLs presented in this report, upon adoption into Chapter 62-304.610, F.A.C., will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC in Subsection 62-302.531(2), F.A.C., for Lake Thonotosassa and Flint Creek, pursuant to Paragraph 62-302.531(2)(a), F.A.C. **Tables 3.1** and **3.2** list the elements of the nutrient TMDLs for Lake Thonotosassa and Flint Creek, respectively, that constitute the site-specific numeric interpretation of the narrative nutrient criterion. **Appendix B** summarizes the relevant details to support the determination that the TMDLs provide for the protection of Lake Thonotosassa and Flint Creek and for the attainment and maintenance of water quality standards in downstream waters (pursuant to Subsection 62-302.531[4], F.A.C.), and to support using the nutrient TMDLs as the site-specific numeric interpretations of the narrative nutrient criterion.

When developing TMDLs to address nutrient impairment, it is essential to reduce those nutrients that typically contribute to excessive plant growth. In Florida waterbodies, nitrogen and phosphorus are most often the limiting nutrients. The limiting nutrient is defined as the nutrient(s) that limit plant growth (both macrophytes and algae) when it is not available in sufficient quantities. A limiting nutrient is a chemical that is necessary for plant growth, but available in quantities smaller than those needed for algae, represented by chlorophyll *a*, and macrophytes to grow.

In the past, management activities to control lake eutrophication focused on phosphorus reduction as phosphorus was generally recognized as the limiting nutrient in freshwater systems. Recent studies, however, support the reduction of both nitrogen and phosphorus to control algal growth in aquatic systems (Conley et al. 2009; Paerl 2009; Lewis et al. 2011; Paerl and Otten 2013). Furthermore, the analysis used in the development of the Florida lake NNC supports this idea, as statistically significant relationships were found between chlorophyll *a* values and both nitrogen and phosphorus concentrations (DEP 2012).

3.2 Site-Specific Response Variable Target Selection

The TMDL targets for Lake Thonotosassa are based on estimated natural background water quality conditions. The analysis that led to the response variable target and nutrient TMDLs considered both predicted lake conditions using a water quality model and paleolimnological results. The concurrence between the water quality modeling and paleolimnological results strongly supported establishing a lake site-specific chlorophyll *a* criterion above the generally applicable NNC. Based on the model results for the natural background loading scenario, DEP selected a chlorophyll *a* value of 32 µg/L as the lake restoration target (**Section 5.4.1**). The target represents the 80th percentile of the annual chlorophyll *a* results. The paleolimnological study, discussed in **Section 5.4.2**, indicates lake chlorophyll *a* levels prior to significant human activity are 29 µg/L. The chlorophyll *a* value from the study is within the range of predicted annual average chlorophyll *a* results for the natural background model period simulated.

The TMDL targets for Flint Creek are based on regression models used to predict creek water quality when the lake achieves natural background water quality. **Section 5.4.3** describes the derivation of the site-specific targets for the creek.

3.3 Numeric Expression of the Site-Specific Numeric Interpretation

DEP concluded that the chlorophyll *a* target representative of natural background conditions, derived using a water quality model and supported by paleolimnological results, is protective of designated uses of the lake. As described in **Section 5.4.1**, this target is equivalent to a chlorophyll *a* criterion of 32 µg/L, expressed as an AGM not to be exceeded more than once in a 3-year period. Algal growth is a natural feature of Florida lakes, although historically far less extreme than current conditions in Lake Thonotosassa. The nutrient loads that attain the chlorophyll *a* criterion were determined using the Watershed Assessment Model, as described in **Chapter 4**, and the U.S. Army Corps of Engineers (USACE) Bathtub Model, as described in **Chapter 5**.

To acknowledge the natural variability in chlorophyll *a* levels because of changes in rainfall, the TN and TP criteria are expressed as maximum long-term (7-year) averages of annual loads identified to meet the chlorophyll *a* criterion. **Table 3.1** summarizes the proposed site-specific interpretation of the narrative nutrient criteria for Lake Thonotosassa. The new water quality standard will incorporate the chlorophyll *a* criterion of 32 µg/L and the associated nutrient loads comprising the TMDLs, which are presented in **Chapter 6**.

For informational purposes only, the TN and TP concentrations corresponding to the chlorophyll *a* criterion of 32 µg/L and the loading criteria are 1.64 and 0.08 mg/L, respectively. These concentrations are AGMs not to be exceeded more than once in a 3-year period when the site-specific TN and TP loads are met. These nutrient concentrations serve as the concentration-based restoration targets.

Table 3.1. Chlorophyll *a*, TN, and TP criteria for Lake Thonotosassa

[1] Maximum long-term 7-year average of annual loads.
[2] AGM concentration not to be exceeded more than once in a 3-year period.

Approach	TN Criterion (lbs/yr)[1]	TP Criterion (lbs/yr)[1]	Chlorophyll *a* Criterion (µg/L)[2]
Water Quality Model	46,962	3,137	32

The water leaving the lake considerably influences water quality in the downstream waters of Flint Creek, as evidenced by the strong relationships between nutrient concentrations near the lake outlet and concentrations in Flint Creek, described in **Section 5.4.3**. Since the flow and water quality of Flint Creek are dominated by lake outflow, the nutrient criteria developed for the lake, based on natural background conditions, determine the appropriate nutrient targets and criteria for Flint Creek. The nutrient criteria and the chlorophyll *a* criteria for the creek are based on the expected creek water quality when the lake nutrient TMDLs are achieved. The linear regression equations explaining the relationships between lake and creek nutrient concentrations are used to derive the Flint Creek criteria. For the Cycle 3 period the creek is not impaired applying the algal mats and macrophytes assessments, based on passing rapid periphyton survey (RPS) and linear vegetation survey (LVS) floral metric results. When the site-specific criteria are attained, the creek is expected to pass the applicable stream floral and faunal metrics (RPS, LVS, and stream condition index) and attain its' designated use as a Class III freshwater.

Table 3.2 summarizes the proposed site-specific interpretation of the narrative nutrient criterion for Flint Creek. The chlorophyll *a*, TN, and TP criteria are expressed as stream AGM concentrations not to be exceeded more than once in a three-year period.

Table 3.2. Chlorophyll *a*, TN, and TP criteria for Flint Creek downstream of Lake Thonotosassa

[1] AGM concentration not to be exceeded more than once in a 3-year period.

Approach	TN Criterion (mg/L)[1]	TP Criterion[1] (mg/L)[1]	Chlorophyll *a* Criterion (µg/L)[1]
Water Quality Model and Regression Analysis	1.78	0.20	12

3.4 Downstream Protection

The Hillsborough River is located downstream of Lake Thonotosassa and Flint Creek. Flint Creek flows into the Hillsborough River segment identified as WBID 1443B. There are no water quality impairments in this segment. The reductions in nutrient loads prescribed in the Lake Thonotosassa TMDLs are not expected to cause nutrient impairments downstream and will actually result in water quality improvements in water segments farther downstream by reducing algal biomass and associated nutrients transported downstream. Furthermore, the TMDLs are based on natural background conditions, which are inherently protective of the waters where the TMDLs apply and downstream waters.

3.5 Endangered Species Consideration

Section 7(a)(2) of the Endangered Species Act (ESA) requires each federal agency, in consultation with the services (i.e., the U.S. Fish and Wildlife Service [FWS], U.S. National Oceanic and Atmospheric Administration [NOAA], and National Marine Fisheries Service [NMFS]), to ensure that any federal action authorized, funded, or carried out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. The EPA must review and approve changes in water quality standards (WQS) such as setting site-specific criteria. Prior to approving WQS changes for aquatic life criteria, the EPA will prepare an Effect Determination summarizing the direct or indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. The EPA categorizes potential effect outcomes as either (1) "no effect," (2) "may affect, not likely to adversely affect," or (3) "may affect: likely to adversely affect."

The service(s) must concur on the Effect Determination before the EPA approves a WQS change. A finding and concurrence by the service(s) of "no effect" will allow the EPA to approve an otherwise approvable WQS change. However, findings of either "may affect, not likely to adversely affect" or "may affect: likely to adversely affect" will result in a longer consultation process between the federal agencies and may result in a disapproval or a required modification to the WQS change.

The FWS online Information for Planning and Conservation (IPaC) tool (see **Appendix D**) identifies the West Indian manatee as a species potentially affected by activities in the area of Lake Thonotosassa and Flint Creek. The manatee inhabits the waters of the lower Hillsborough River downstream of the Hillsborough River Reservoir dam, which prevents the manatee from moving farther upstream. The confluence of Flint Creek and the Hillsborough River is 22 river miles upstream of the dam.

Chapter 4: Assessment of Sources

4.1 Types of Sources

An important part of the TMDL analysis is the identification of pollutant source categories, source subcategories, or individual sources of the pollutant of concern in the target watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point sources or nonpoint sources. Historically, the term "point sources" has meant discharges to surface waters that typically have a continuous flow via a discernable, confined, and discrete conveyance, such as a pipe. Domestic and industrial wastewater treatment facilities (WWTFs) are examples of traditional point sources. In contrast, the term "nonpoint sources" was used to describe intermittent, rainfall-driven, diffuse sources of pollution associated with everyday human activities, including runoff from urban land uses, agriculture, silviculture, and mining; discharges from septic systems; and atmospheric deposition.

However, the 1987 amendments to the CWA redefined certain nonpoint sources of pollution as point sources subject to regulation under the EPA's National Pollutant Discharge Elimination System (NPDES) Program. These nonpoint sources included certain urban stormwater discharges, such as those from local government master drainage systems, construction sites over five acres, and a wide variety of industries (see **Appendix A** for background information on the federal and state stormwater programs).

To be consistent with CWA definitions, the term "point source" is used to describe traditional point sources (such as domestic and industrial wastewater discharges) and stormwater systems requiring an NPDES stormwater permit when allocating pollutant load reductions required by a TMDL (see **Section 6.1** on **Expression and Allocation of the TMDL**). However, the methodologies used to estimate nonpoint source loads do not distinguish between NPDES and non-NPDES stormwater discharges, and as such, this source assessment section does not make any distinction between the two types of stormwater.

4.2 Point Sources

4.2.1 Wastewater Point Sources

One permitted WWTF in the watershed can discharge reclaimed water into stormwater storage lake systems that intermittently discharge to surface waters. The City of Plant City Water Reclamation Facility, NPDES Permit Number FL0026557, is a domestic wastewater treatment plant with a design flow of 10.0 million gallons per day (mgd). The facility provides advanced wastewater treatment (AWT) and high-level disinfection. The primary surface water discharge is to the East Canal, located outside the Lake Thonotosassa Watershed. The permit allows the facility to transfer reclaimed water to two stormwater storage lake systems located on the Walden Lake Golf Course that intermittently discharge into a drainage ditch system routed to

Spartman Branch, a tributary to Baker Creek, which flows into the lake. The facility has only transferred reclaimed water to the golf course lake system for a one-day event in June 2013, to verify operation of the system.

4.2.2 Municipal Separate Storm Sewer System (MS4) Permittees

The Lake Thonotosassa Watershed and Flint Creek Watershed below the lake are covered by one NPDES MS4 Phase I permit (FLS000006). The Florida Department of Transportation (FDOT) District 7 and the City of Plant City are co-permittees in the MS4 permit. For more information on MS4s in the watershed, send an email to NPDES-stormwater@dep.state.fl.us. **Table 4.1** lists the permittees/co-permittees and their MS4 permit numbers.

Table 4.1. NPDES MS4 permits with jurisdiction in the Lake Thonotosassa Watershed and the Flint Creek Watershed below the lake

Permit Number	Permittee/Co-Permittees	Phase
FLS000006	Hillsborough County	I
FLS266213	City of Plant City	I
FLS266221	FDOT District 7 – Hillsborough	I

4.3 Nonpoint Sources

Pollutant sources that are not NPDES wastewater or stormwater dischargers are generally considered nonpoint sources. Nutrient loadings to Lake Thonotosassa and Flint Creek are primarily generated from nonpoint sources. Nonpoint sources addressed in this analysis primarily include loadings from surface runoff, groundwater seepage entering the lake, the recycling of nutrients within the lake, and precipitation directly onto the lake surface (atmospheric deposition).

4.3.1 Land Uses

Land use is one of the most important factors in determining nutrient loadings from a watershed. Nutrients can be flushed into a receiving water through surface runoff and stormwater conveyance systems during stormwater events. Both human land use areas and natural land areas generate nutrients. However, human land uses typically generate more nutrient loads per unit of land surface area than natural lands can produce. **Tables 4.2** and **4.3** summarize the SWFWMD 2009 land use in the watersheds for Lake Thonotosassa and Flint Creek below the lake, respectively. **Figure 4.1** shows the information graphically. This particular land use year is provided to show the information used in the water and nutrient budget study conducted for the SWFWMD (Environmental Research and Design [ERD] 2012). Information from this study was applied in the development of watershed loadings to the lake, described in **Section 4.4**. The watershed loadings were then used in the development of the lake water quality model documented in **Chapter 5**.

The Lake Thonotosassa Watershed covers an area of 36,112 acres (56.4 square miles), and 55 % of the area comprises urban land. Low-density residential is the predominant urban land use, covering 20 % of the watershed. Agriculture makes up 21 %, and the predominant agricultural land uses are cropland/pastureland (8 %) and row crops (6 %). Natural land cover includes wetlands and upland forest, comprising 13 % and 5 %, respectively, of the drainage area.

The Flint Creek Watershed below the lake is 8,405 acres (13.1 square miles) in size. Low-density residential is the predominant land use in the creek's watershed downstream of the lake, covering 41 % of the watershed, and this makes up 89 % of the total urban area. Agricultural land covers 34 % of the drainage basin, with cropland/pastureland and row crops being the predominant agricultural land uses. The third largest land area is wetlands, covering 14 % of the watershed. The three largest land use classifications account for 88 % of the watershed land area.

The most recent land use information available for the watershed consists of preliminary 2014 land use results DEP received from the SWFWMD in 2018. The 2014 land use coverage for the lake watershed was summarized for comparison with the 2009 land use. **Figure 4.2** shows the land use percentages for each year. The results indicate that there were minimal changes in land use composition between 2009 and 2014.

Table 4.2. SWFWMD land use in the Lake Thonotosassa Watershed in 2009

Land Use Code	Land Use Classification	Acres	% of Watershed
1100	Low-Density Residential	7,269	20.13
1200	Medium-Density Residential	5,072	14.04
1300	High-Density Residential	2,814	7.79
1400	Commercial and Services	1,684	4.66
1500	Industrial	602	1.67
1600	Extractive	245	0.68
1700	Institutional	398	1.10
1800	Recreational	622	1.72
1900	Open Land	1,305	3.61
2100	Cropland and Pastureland	2,797	7.75
2140	Row Crops	2,221	6.15
2200	Tree Crops	1,334	3.69
2300	Feeding Operations	55	0.15
2400	Nurseries and Vineyards	536	1.48
2500	Specialty Farms	0	0.00
2600	Other Open Land (Rural)	759	2.10
3000	Rangeland	9	0.03
4000	Upland Forest	1,732	4.80
5000	Water	1,033	2.86
6000	Wetlands	4,570	12.65
7000	Barren Land	7	0.02
8000	Transportation, Communication and Utilities	1,048	2.90
Total		**36,112**	**100.00**

Table 4.3. SWFWMD land use in the Flint Creek Watershed below the lake in 2009

Land Use Code	Land Use Classification	Acres	% of Watershed
1100	Low-Density Residential	3,441	40.9
1200	Medium-Density Residential	46	0.5
1300	High-Density Residential	7	0.1
1400	Commercial and Services	4	0.0
1500	Industrial	9	0.1
1700	Institutional	72	0.9
1800	Recreational	12	0.1
1900	Open Land	257	3.1
2100	Cropland and Pastureland	1,404	16.7
2140	Row Crops	472	5.6
2200	Tree Crops	125	1.5
2300	Feeding Operations	52	0.6
2400	Nurseries and Vineyards	212	2.5
2500	Specialty Farms	201	2.4
2600	Other Open Land (Rural)	393	4.7
3000	Rangeland	30	0.4
4000	Upland Forest	386	4.6
5000	Water	116	1.4
6000	Wetlands	1,148	13.7
8000	Transportation, Communication and Utilities	18	0.2
Total		**8,405**	**100.0**

4.3.2 Onsite Sewage Treatment and Disposal Systems (OSTDS)

OSTDS, including septic tanks, are commonly used where providing central sewer service is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDS are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. OSTDS can be a source of nutrients, pathogens, and other pollutants to both groundwater and surface water.

The Florida Department of Health (FDOH) maintains a list of septic tanks by county, and the Hillsborough County 2018 database was used to determine the number of septic tanks in the area. The number of septic tanks calculated for the Lake Thonotosassa Watershed was 5,414, and for the Flint Creek Watershed downstream of the lake the number was 1,677. **Figure 4.3** shows the OSTDS locations in both watersheds.

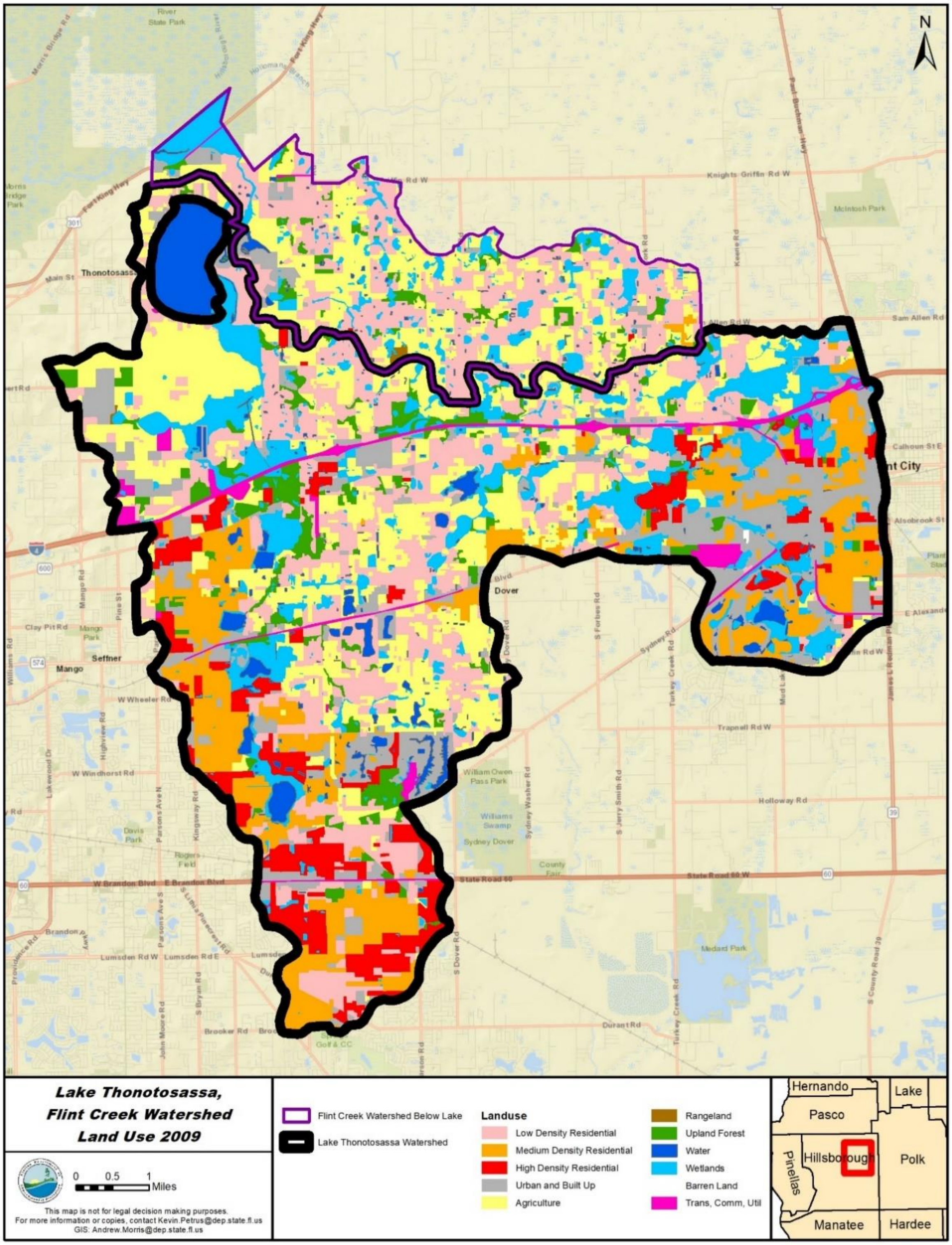

Figure 4.1. Land use in the Lake Thonotosassa Watershed and the Flint Creek Watershed below the lake in 2009

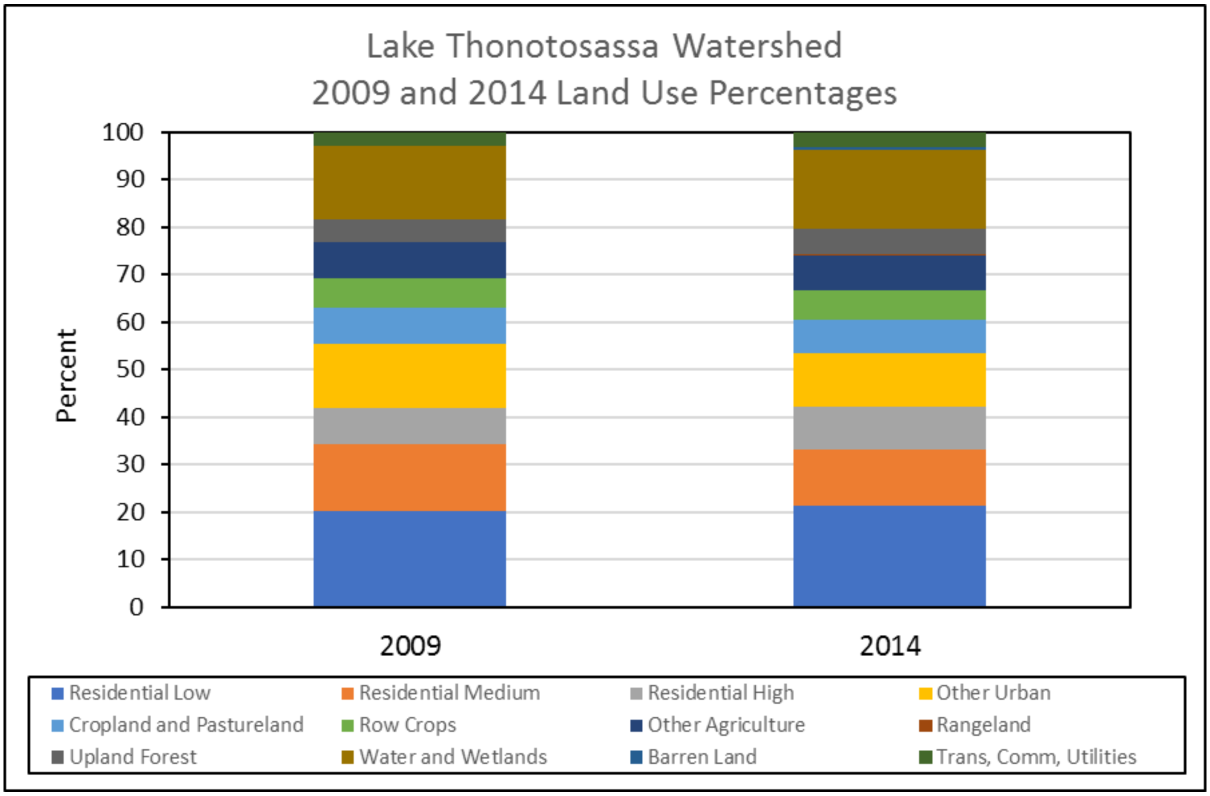

Figure 4.2. Lake Thonotosassa Watershed land use composition in 2009 and 2014

4.3.3 Atmospheric Deposition

Nutrient loadings from the atmosphere are an important component of the nutrient budget in many Florida lakes. Nutrients are delivered through two pathways: wet atmospheric deposition with precipitation and dry particulate-driven deposition. Atmospheric deposition to terrestrial portions of the lake's watershed is assumed to be accounted for in the loading rates used to estimate the watershed loading from land. Loading from atmospheric deposition directly onto the lake surface is accounted for in the watershed model, which is described in the following section.

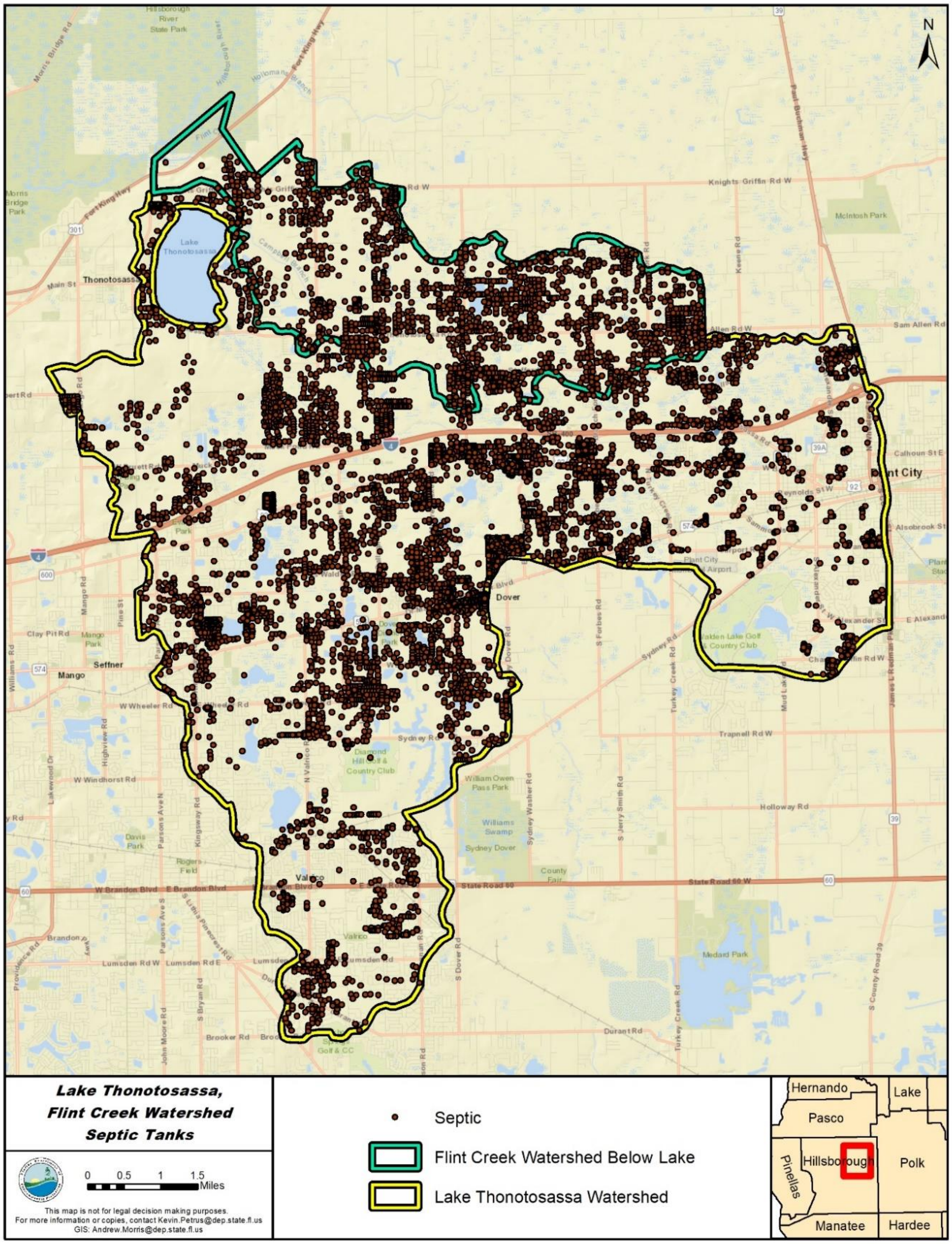

Figure 4.3. OSTDS in the Lake Thonotosassa Watershed and the Flint Creek Watershed below the lake

4.4 Estimating Watershed Loadings

4.4.1 Current Conditions

In 2012 a lake water and nutrient budget study was completed for the SWFWMD (ERD 2012), and as part of this work the Watershed Assessment Model (WAM) was applied to estimate loading inputs to the lake (Soil and Water Engineering Technology [SWET] 2011). WAM simulates both surface water and groundwater flow and water quality by taking into account land source loads and appropriate attenuation processes along the flow paths within watersheds. WAM is a geographic information system (GIS)–based model that allows for simulation and evaluation of the environmental effects of land use changes and associated land use practices in complex watersheds. The WAM application for Lake Thonotosassa was used to estimate flow and nutrient loads to the lake from the watershed and direct contributions to the lake for the period from 1998 to 2010. The model was calibrated to flow and water quality data collected in tributaries to the lake.

DEP subsequently updated WAM to include revising the Lake Thonotosassa WAM to operate in Environmental Systems Research Institute (ESRI) ArcMap 10.3 (SWET 2017a), which is the GIS software used to analyze and display model input and output. Since the original model was created, WAM has undergone several revisions, including a significant number of updates to the underlying databases as well as corrections to model algorithms. Other model updates included remapping some soil types, modifying the default values for nutrient concentrations in rainfall, and changing some reach bottom elevations to prevent backflow from the lake into the downstream segments of the model reach network (SWET 2017a). Some of the data, including rainfall, land use information (2009 land use), and stream network data were imported directly from the original WAM application. The updated model was developed to ensure that the results produced compare satisfactorily with the original model results. The WAM updates along with the hydrologic and nutrient model results are documented in SWET 2017a.

WAM accounts for the external loads entering the lake from Baker Creek and loadings from surface water and groundwater flow from land immediately adjacent to the lake. Additionally, the model accounts for direct contributions to the lake from groundwater flow and rainfall.

Table 4.4 lists the annual flow and nutrient loadings to the lake based on the updated WAM. DEP used these loadings as inputs to the lake water quality model for the simulation of current conditions, explained in **Chapter 5**.

4.4.2 Background Conditions

After WAM was updated for the current condition loading simulation, the model was used to develop a background loading condition scenario (SWET 2017b). The loadings under background or predevelopment conditions were estimated by removing any point source discharges and changing all anthropogenic land uses (e.g., urban and agricultural land) to the natural land cover prior to human habitation. **Table 4.5** lists the annual flow and nutrient loading results for the background condition scenario. The loadings for the background condition scenario were then applied in the lake water quality model to estimate the predevelopment lake conditions.

Table 4.4. WAM-simulated current condition hydrologic and nutrient loadings to Lake Thonotosassa

ac-ft/yr = Acre-feet per year

Year	Flow (ac-ft/yr)	TN Loads (lbs/yr)	TP Loads (lbs/yr)
1998	57,600	151,047	48,679
1999	22,284	47,257	19,079
2000	23,887	50,748	19,984
2001	21,418	46,737	18,378
2002	24,490	57,038	23,635
2003	36,025	86,753	33,830
2004	53,249	133,744	52,906
2005	18,776	44,411	16,571
2006	11,157	23,525	9,956
2007	19,284	40,010	16,905
2008	10,084	21,531	8,891
2009	26,832	61,745	23,769
2010	20,927	52,548	19,415
Average	**26,616**	**62,853**	**24,000**

Table 4.5. WAM-simulated background condition hydrologic and nutrient loadings to Lake Thonotosassa

Year	Flow (ac-ft/yr)	TN Loads (lbs/yr)	TP Loads (lbs/yr)
1998	45,689	102,639	7,014
1999	26,920	50,327	3,765
2000	19,172	35,815	2,657
2001	14,684	29,881	1,973
2002	16,652	35,995	2,175
2003	27,304	63,589	3,930
2004	42,220	93,356	6,231
2005	9,311	19,774	1,229
2006	5,085	11,687	620
2007	11,456	32,617	1,546
2008	5,335	13,649	685
2009	20,337	50,439	2,768
2010	14,423	36,216	1,948
Average	**19,891**	**44,306**	**2,811**

Chapter 5: Determination of Assimilative Capacity

5.1 Determination of Loading Capacity

Nutrient enrichment and the resulting problems related to eutrophication tend to be widespread and are frequently manifested far (in both time and space) from their sources. Addressing eutrophication involves relating water quality and biological effects such as photosynthesis, decomposition, and nutrient recycling as acted on by environmental factors (rainfall, point source discharge, etc.) to the timing and magnitude of constituent loads supplied from various categories of pollution sources. Assimilative capacity should be related to some specific hydrometeorological condition during a selected period or to some range of expected variation in these conditions.

The goal of this TMDL analysis is to determine the assimilative capacity of Lake Thonotosassa and Flint Creek and to identify the maximum allowable TN and TP loadings from the watersheds, so that the lake and creek will meet the TMDL targets and thus maintain their function and designated use as Class III waters.

5.2 Evaluation of Water Quality Conditions

Figures 5.1 through **5.3** show the times series of nutrient variable AGMs from 1998 to 2017 for Lake Thonotosassa, Flint Creek, and Campbell Branch. The graphs include the results for Campbell Branch, as this stream is the main tributary to Flint Creek below the lake outlet.

Figure 5.1 shows the lake chlorophyll *a* AGMs varied from 78 µg/L in 2005 to 171 µg/L in 2017, and the Flint Creek chlorophyll *a* AGMs ranged from 22 µg/L in 2000 to 94 µg/L in 2011. The Campbell Branch chlorophyll *a* results, although limited, show that the AGMs were at or below 3 µg/L from 2010 to 2016.

The TN AGMs in the last 20 years varied from a low of 1.36 mg/L to a high of 3.63 mg/L in the lake, while in Flint Creek the results ranged from 1.60 to 3.04 mg/L (**Figure 5.2**). The TN results for Campbell Branch ranged between 1.10 mg/L in 2011 to 1.44 mg/L in 2014.

The TP AGMs in the lake ranged from a low of 0.16 mg/L in 2008 to a high of 0.52 mg/L in 2004, while the Flint Creek AGMs varied from 0.25 mg/L in 2009 to a high of 0.68 mg/L in 2000 (**Figure 5.3**). The Campbell Branch TP AGMs between 2010 and 2016 were generally higher than the results in the lake and Flint Creek, and ranged from 0.30 to 0.45 mg/L.

The lake is the major inflow to Flint Creek, and the results show that the chlorophyll *a*, TN, and TP AGMs in the creek exhibit a similar temporal pattern as the lake results.

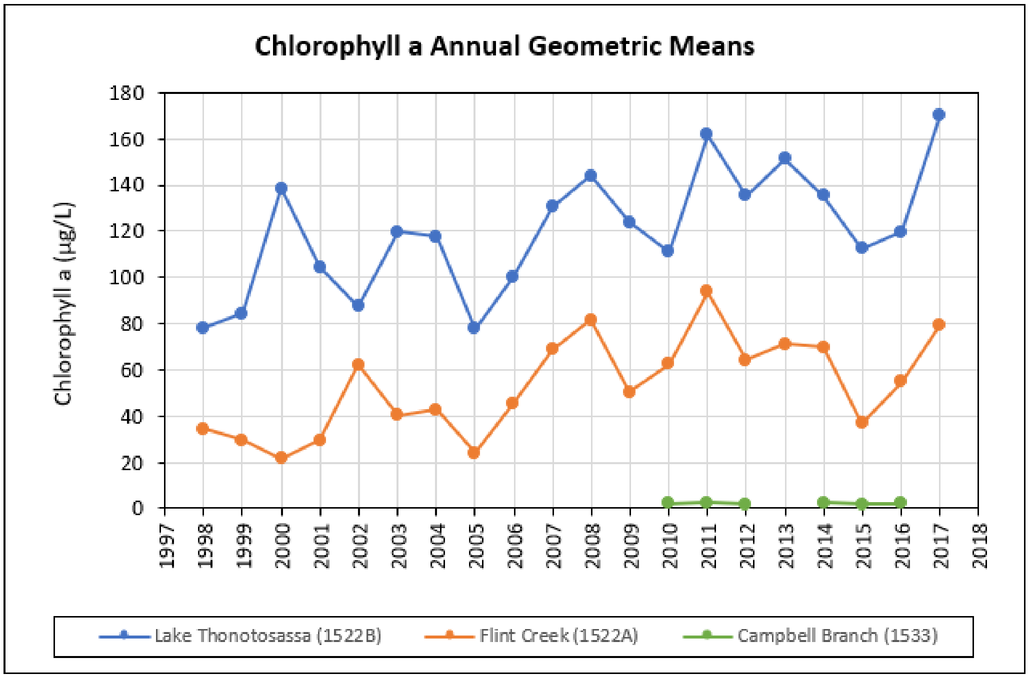

Figure 5.1. Chlorophyll *a* AGM results, 1998–2017

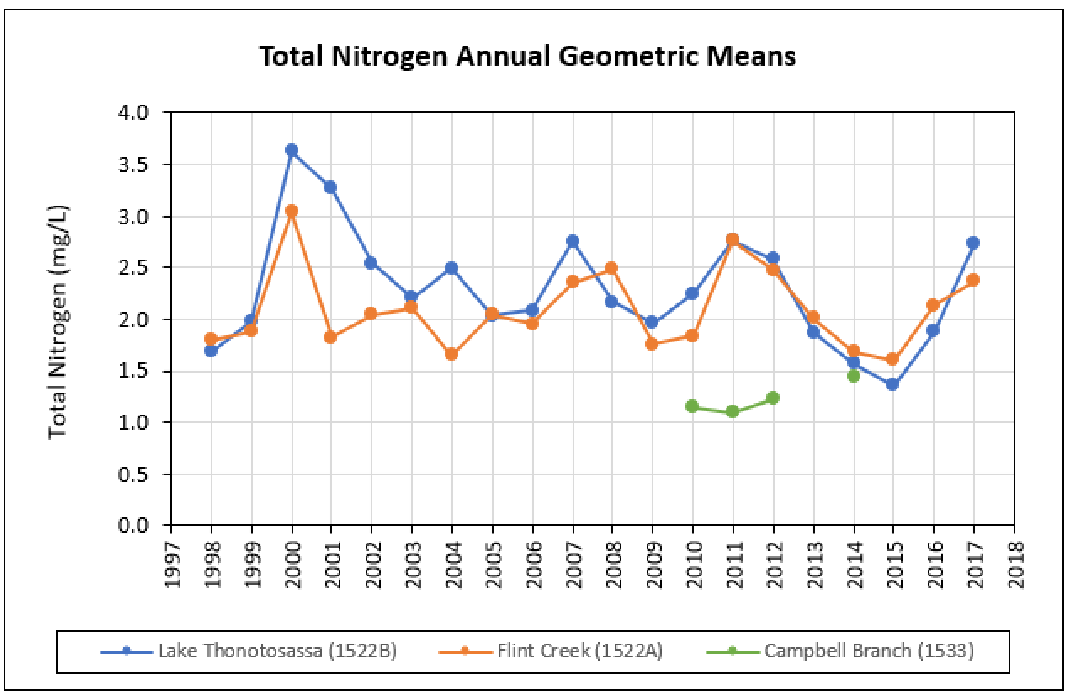

Figure 5.2. TN AGM results, 1998–2017

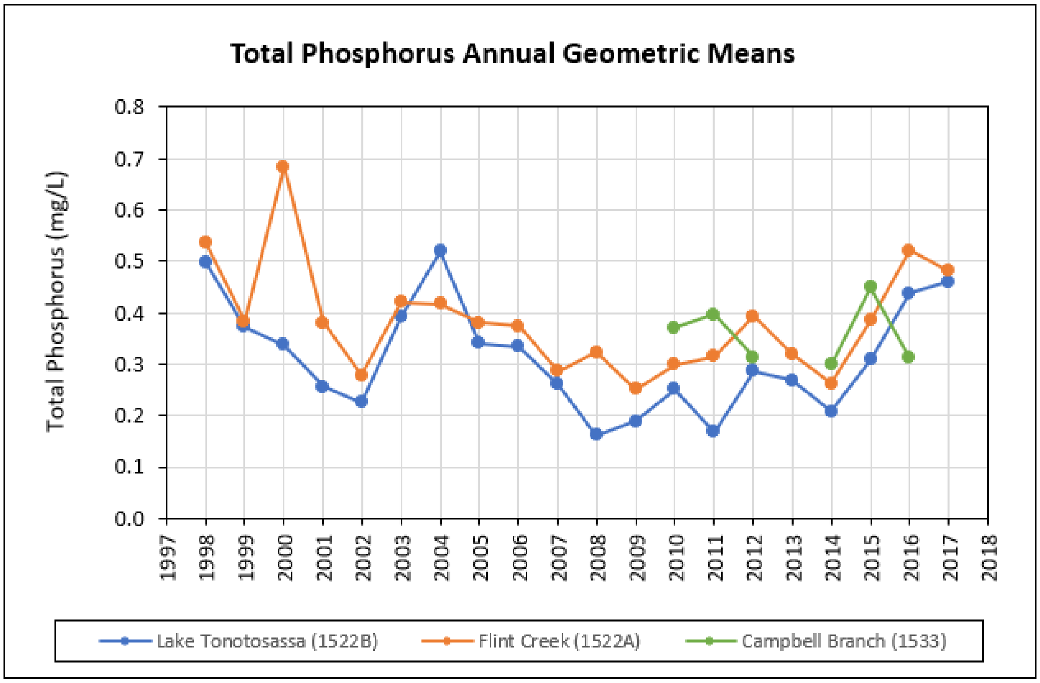

Figure 5.3. TP AGM results, 1998–2017

The lake chlorophyll *a*, TN, and TP AGMs are compared with annual average lake water levels in **Figures 5.4, 5.5,** and **5.6**, respectively, to evaluate the potential influence of hydrology on lake water quality. The water level results are recorded at SWFWMD Site 18605. The comparison indicates a relatively small positive relationship between lake level and chlorophyll *a* on an annual basis (**Figure 5.4**), where the lake level explains 24 % of the variation in chlorophyll *a* AGMs. Small inverse relationships exist between annual lake water levels and the TN and TP AGM concentrations. The relationship between the TN AGMs and lake level is statistically significant. However, the lake level only explains 20 % of the variation in TN AGMs (r-square value = 0.20, p value < 0.05).

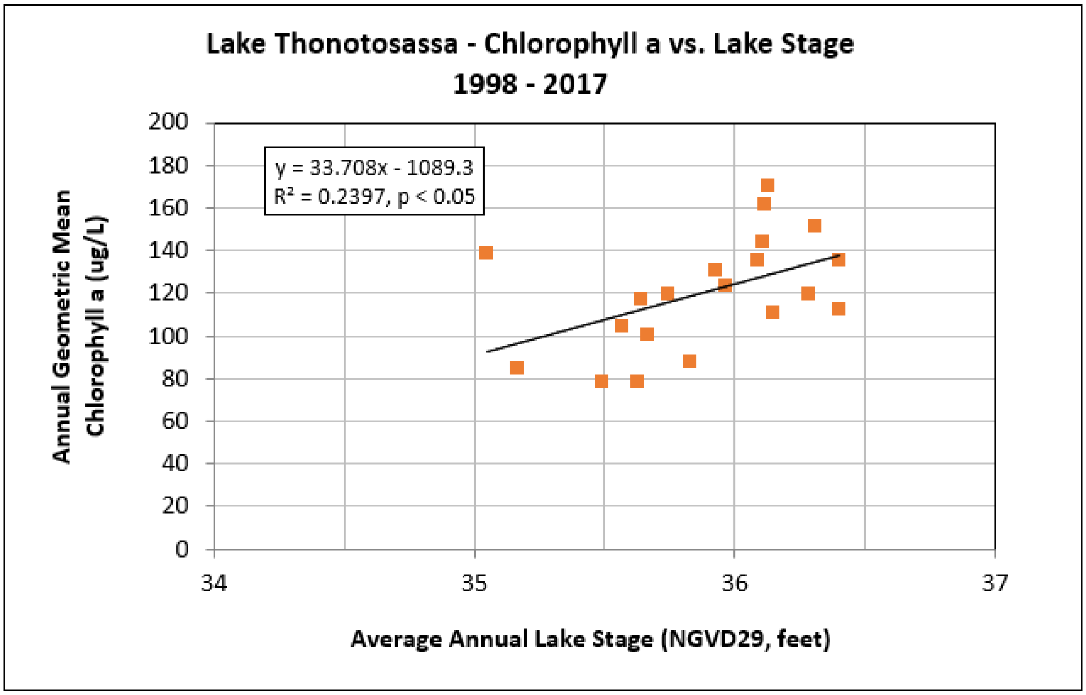

Figure 5.4. Lake Thonotosassa chlorophyll a AGMs versus lake levels

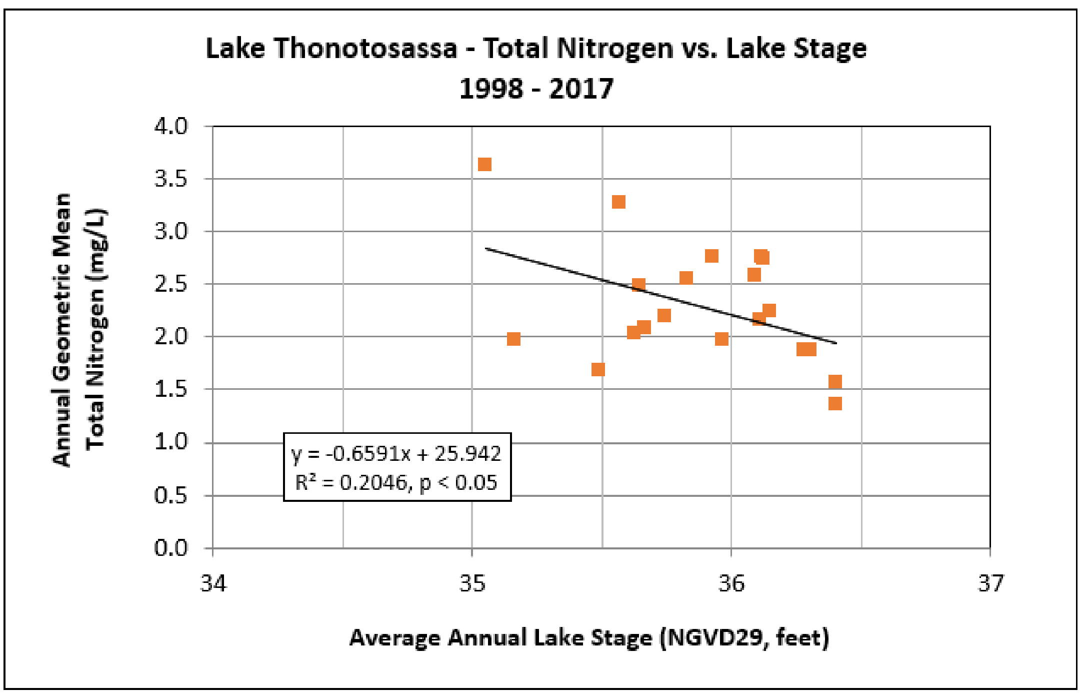

Figure 5.5. Lake Thonotosassa TN AGMs versus lake levels

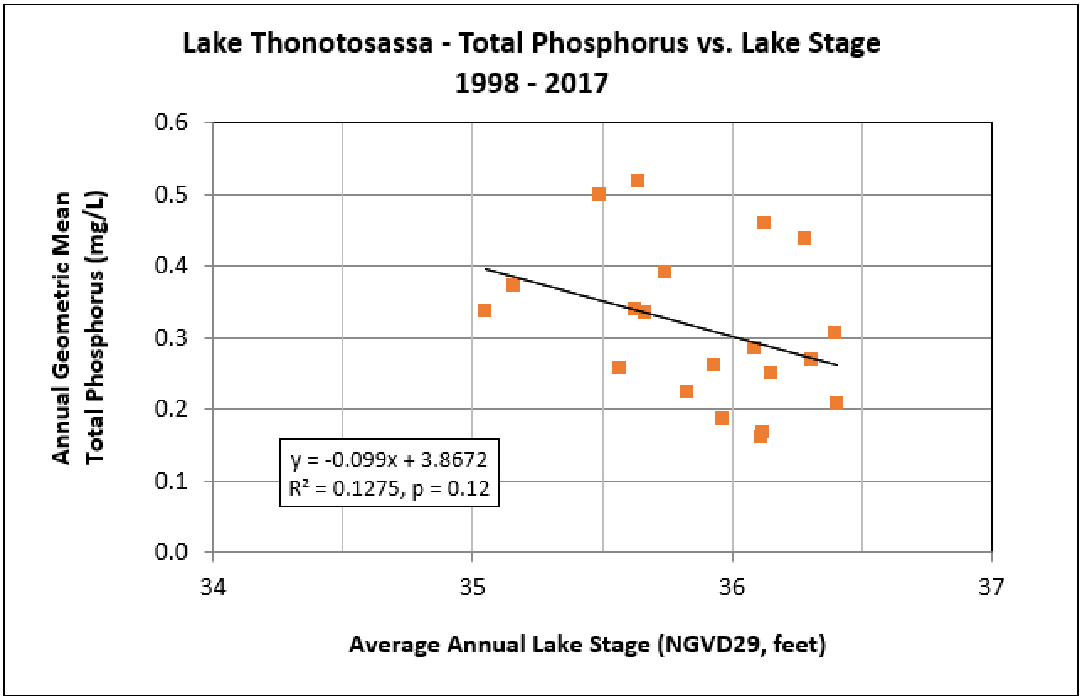

Figure 5.6. Lake Thonotosassa TP AGMs versus lake levels

5.3 Critical Conditions and Seasonal Variation

The estimated assimilative capacity is based on annual conditions, rather than critical/seasonal conditions, because (1) the methodology used to determine assimilative capacity does not lend itself very well to short-term assessments, (2) DEP is generally more concerned with the net change in overall primary productivity in the segment, which is better addressed on an annual basis, and (3) the methodology used to determine impairment is based on annual conditions (AGM values).

5.4 Water Quality Modeling and Analysis to Determine Assimilative Capacity

Two methods were used to develop the water quality restoration targets to address the nutrient impairment of Lake Thonotosassa. The first was model-simulated results that predicted lake water quality under nutrient loading conditions that existed when the lake had balanced aquatic flora and fauna communities. The second was paleolimnological results developed using methods commonly applied to infer historical lake water quality conditions.

Chapter 3 described the generally applicable NNC; and in order to avoid abating natural conditions, DEP examined the model-based prediction of natural background conditions and the lake nutrient concentrations established using the paleolimnological reconstruction of past conditions. The results from these two approaches support establishing the restoration targets at the natural background conditions.

5.4.1 Water Quality Models

Two models were used to simulate water quality conditions in Lake Thonotosassa. The WAM was applied to the Lake Thonotosassa Watershed, as described in **Chapter 4**, to simulate watershed flows and nutrient loads to the lake. A second model (Bathtub) simulated in-lake nutrient and chlorophyll conditions based on watershed inputs, meteorological conditions, and the physical characteristics of the lake. The following section summarizes the modeling approach used to establish TN and TP targets under natural conditions.

The Bathtub eutrophication model is a suite of empirically derived steady-state models developed by the USACE Waterways Experimental Station. The primary function of these models is to estimate nutrient concentrations and algal biomass resulting from different patterns of nutrient loadings. The procedures for selection of the appropriate model for a particular lake are described in the *Bathtub User's Manual* (Walker 1999). The empirical prediction of lake eutrophication using this approach typically can be described as a two-stage procedure using the following two categories of models (Walker 1999):

The **nutrient balance model** relates in-lake nutrient concentration to the external nutrient loadings, morphometry, and hydraulics of the lake.

The **eutrophication response model** describes relationships among eutrophication indicators in the lake, including nutrient levels, chlorophyll *a*, transparency, and hypolimnetic oxygen depletion.

Figure 5.7 shows the scheme used by Bathtub to relate the external loading of nutrients to the in-lake nutrient concentrations and the physical, chemical, and biological response of the lake to the level of nutrients. The model includes a suite of phosphorus and nitrogen sedimentation models, along with a set of chlorophyll and Secchi depth models. The nutrient balance models assume that the net accumulation of nutrients in a lake is the difference between nutrient loadings into the lake from various sources and the nutrients carried out through outflow and nutrient losses through whatever decay processes occur inside the lake. Different limiting factors such as nitrogen, phosphorus, light, or flushing are considered in the selection of an appropriate chlorophyll model.

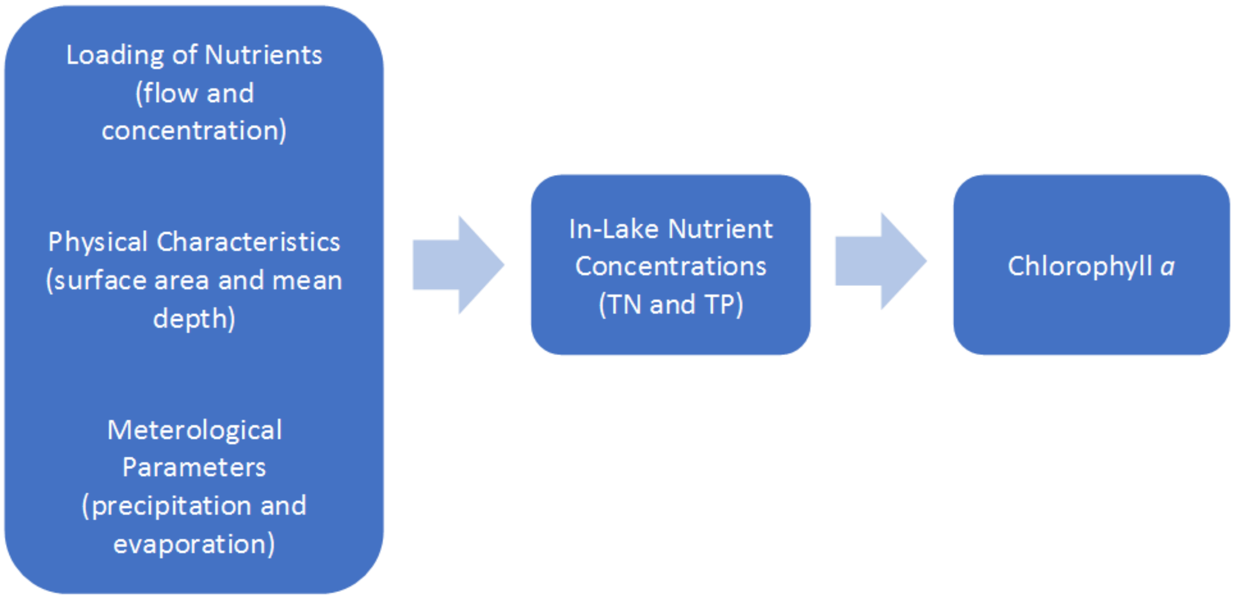

Figure 5.7. Bathtub concept scheme

The Bathtub model was set up to simulate in-lake TN, TP, and chlorophyll *a* concentrations each year from 1999 to 2010 based on simulated TN and TP loads from WAM. The WAM application started simulation in 1998; however, this year was a spin-up period for the model to reach equilibrium, and the actual lake modeling began in 1999. Arithmetic mean concentrations for chlorophyll *a*, TN, and TP calculated from available lake water quality data were used to calibrate the Bathtub application and guide the selection of nitrogen, phosphorus, and chlorophyll models.

Model Option 5, based on the Vollenweider equation, was selected to simulate phosphorus sedimentation. Model Option 6, simple first order, was selected as the nitrogen sedimentation model. Chlorophyll Model 3 was selected to simulate chlorophyll *a*.

After the set of models was selected, calibration for TN and TP was achieved by applying the internal loading rate functions for both TN and TP to approximate the measured in-lake mass. The internal loading rates account for in-lake processes that recycle mass within the lake and inputs of nitrogen through nitrogen fixation. The nutrient budget study estimated loadings, and the enumeration of the phytoplankton community indicates that these internal processes occur in the lake. Chlorophyll *a* concentrations were calibrated using the Bathtub calibration coefficient. The internal loading rates and calibration factor were adjusted each year. **Table 5.1** lists the annual observed data averages and the calibrated Bathtub model results.

Table 5.1. Observed and Bathtub-simulated annual average results, 1999–2010

Year	Chlorophyll Observed (µg/L)	Chlorophyll Simulated (µg/L)	Ratio	TN Observed (µg/L)	TN Simulated (µg/L)	Ratio	TP Observed (µg/L)	TP Simulated (µg/L)	Ratio
1999	100	104	1.04	2,093	2,172	1.04	389	391	1.01
2000	170	169	0.99	3,913	3,918	1.00	404	411	1.02
2001	124	125	1.00	3,469	3,459	1.00	290	295	1.02
2002	94	96	1.02	2,678	2,730	1.02	231	236	1.02
2003	122	123	1.01	2,266	2,301	1.02	397	400	1.01
2004	129	131	1.02	2,592	2,558	0.99	533	508	0.95
2005	100	104	1.04	2,136	2,119	0.99	360	353	0.98
2006	104	101	0.97	2,281	2,242	0.98	372	368	0.99
2007	138	140	1.01	3,023	3,024	1.00	311	305	0.98
2008	149	148	1.00	2,546	2,551	1.00	197	204	1.04
2009	131	129	0.99	2,139	2,139	1.00	218	235	1.08
2010	129	125	0.97	2,501	2,492	1.00	280	280	1.00
Long-Term Average	**124**	**124**	**1.00**	**2,636**	**2,642**	**1.00**	**332**	**332**	**1.00**

To develop TN and TP targets based on the Bathtub modeling approach, the WAM simulations for natural background conditions (SWET 2017b) were used for the 1999–2010 period. The same TN and TP models and calibration factors used to simulate current conditions were used to simulate natural background conditions. The background condition internal loads were estimated by applying a factor to the internal loads used for model calibration. This factor is based on the percent reduction between the current chlorophyll *a* concentrations and the predevelopment concentration based on the paleolimnological analysis. **Table 5.2** lists the predicted average lake water quality for the background loading condition. The chlorophyll *a* and TP paleolimnological results (29 and 46 µg/L, respectively) fall within the range of the model-predicted annual average concentrations.

Simulated annual average concentrations of chlorophyll *a*, TN, and TP for the natural background condition from 1999 to 2010 were converted to AGMs for each year using the linear relationships between annual average and AGM concentrations from the lake dataset used in developing the NNC (Ken Weaver, DEP, personal communication, 2015). **Table 5.3** lists the simulated annual average and corresponding AGM results for the natural background condition.

The 80th percentile of the chlorophyll *a* AGMs is used to express the site-specific chlorophyll *a* criterion in a manner consistent with the expression of the generally applicable chlorophyll *a* criterion. DEP determined that, statistically, a long-term 80th percentile is consistent with an exceedance frequency of no more than once in a 3-year period. The 80th percentile chlorophyll *a* AGM for the natural background simulation period is 32 µg/L (**Table 5.3**). The chlorophyll *a*

AGM value of 32 µg/L not to be exceeded more than once in a 3-year period represents the lake's restoration target and the site-specific chlorophyll *a* criterion. The TN and TP 80th percentile AGM values are 1.64 and 0.08 mg/L, respectively.

Table 5.2. Bathtub model annual average results for the natural background loading condition

Year	Chlorophyll Natural Background (µg/L)	TN Natural Background (µg/L)	TP Natural Background (µg/L)
1999	25	959	71
2000	36	1,601	90
2001	24	1,717	59
2002	14	1,374	35
2003	36	1,277	80
2004	38	1,259	103
2005	37	1,281	89
2006	40	1,584	97
2007	34	1,964	66
2008	25	1,748	36
2009	24	1,284	38
2010	26	1,430	51
Minimum	**14**	**959**	**35**
Average	**30**	**1,457**	**68**
Median	**30**	**1,402**	**69**
Maximum	**40**	**1,964**	**103**

Table 5.3. Lake Thonotosassa natural background condition annual average and AGM concentrations

[1] Calculated based on linear relationships between annual average and AGM concentrations in the lake dataset used for NNC development.

Year	Chlorophyll *a* Annual Average (µg/L)	Chlorophyll *a* AGM (µg/L)[1]	TN Annual Average (mg/L)	TN AGM (mg/L)[1]	TP Annual Average (mg/L)	TP AGM (mg/L)[1]
1999	25	22	0.96	0.93	0.07	0.07
2000	36	31	1.60	1.55	0.09	0.08
2001	24	21	1.72	1.66	0.06	0.05
2002	14	12	1.37	1.33	0.04	0.03
2003	36	31	1.28	1.23	0.08	0.07
2004	38	33	1.26	1.22	0.10	0.10
2005	37	32	1.28	1.24	0.09	0.08
2006	40	35	1.58	1.53	0.10	0.09
2007	34	30	1.96	1.90	0.07	0.06
2008	25	22	1.75	1.69	0.04	0.03
2009	24	21	1.28	1.24	0.04	0.04
2010	26	23	1.43	1.38	0.05	0.05
80th Percentile	**37**	**32**	**1.69**	**1.64**	**0.09**	**0.08**

Figure 5.8 shows annual rainfall totals for the model simulation period, measured at the Florida Automated Weather Network (FAWN) station at Dover. This station, located near the center of the Lake Thonotosassa Watershed, has the most complete rainfall record of the weather stations in the area. The long-term annual average rainfall at this location is 48.6 inches. During the simulation period, rainfall was above average in 2002, 2004, and 2005. Drier than average periods occurred from 1999 to 2001 and 2006 to 2008.

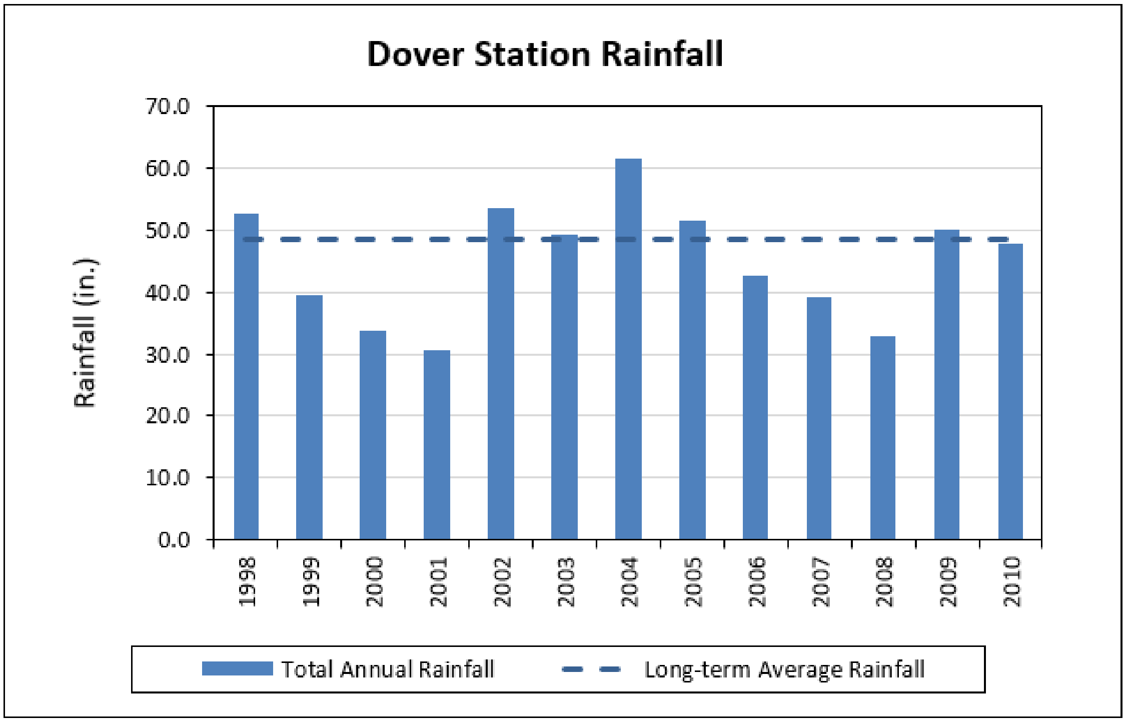

Figure 5.8. Dover weather station rainfall, 1998–2010

5.4.2 Paleolimnological Assessment

Lake sediment cores were collected from Lake Thonotosassa in 1994 to characterize historical water quality conditions (Brenner et al. 1996) when the lake was minimally disturbed by human activity. Since this study was completed, other methods have been developed to estimate water quality based on the characterization of the diatom community in lake sediments. Updated analysis, using weighted-averaging regression methods, was applied using the sediment results from the 1994 sampling. Additional sampling was conducted at the same sites in 2000 for sedimented algal and cyanobacterial pigment analysis, which provides further information about the phytoplankton community (Whitmore et al. 2018).

Appendix C summarizes the recent paleolimnological analysis performed and documents the updated diatom-based lake water quality inferences in the sediment profile. The results for the deepest section of the core represent an estimate of lake nutrient conditions circa 1884. As shown in Table 1 in **Appendix C,** the limnetic TP concentration at the base of the core was 46 µg/L and the chlorophyll *a* concentration was 29 µg/L.

5.4.3 Flint Creek Criteria Development

As the outflow from Lake Thonotosassa is the largest input to Flint Creek, the relationships between water quality in the lake and creek were used to derive restoration targets that address the nutrient impairment of Flint Creek.

Figures 5.9, 5.10, and **5.11** show the relationships between chlorophyll *a*, TN, and TP AGMs, respectively, at the Hillsborough County long-term sampling locations at the lake outlet (HCEPC 118) and at Flint Creek at U.S. Highway 301 (HCEPC 148). The graphs show strong significant relationships between water quality near the lake outlet and in Flint Creek. The lake chlorophyll *a* accounts for 62 % of the variation in the creek values ($p < 0.05$). For nutrients, the lake TN and TP AGMs account for 80 % of the variation in the creek AGMs ($p < 0.05$).

The Flint Creek nutrient AGMs are predicted based on these relationships for the Lake Thonotosassa natural background condition shown in **Table 5.4**. The creek nutrient concentrations based on the lake natural background conditions are the Flint Creek restoration targets. Consistent with the expression of the lake chlorophyll *a* target, the 80th percentiles of the nutrient AGMs for the period from 1999 to 2010 are used for the creek restoration targets. The creek targets are a chlorophyll *a* AGM of 12 µg/L, TN AGM of 1.78 mg/L, and TP AGM of 0.20 mg/L, not to be exceeded more than once in any consecutive 3-year period.

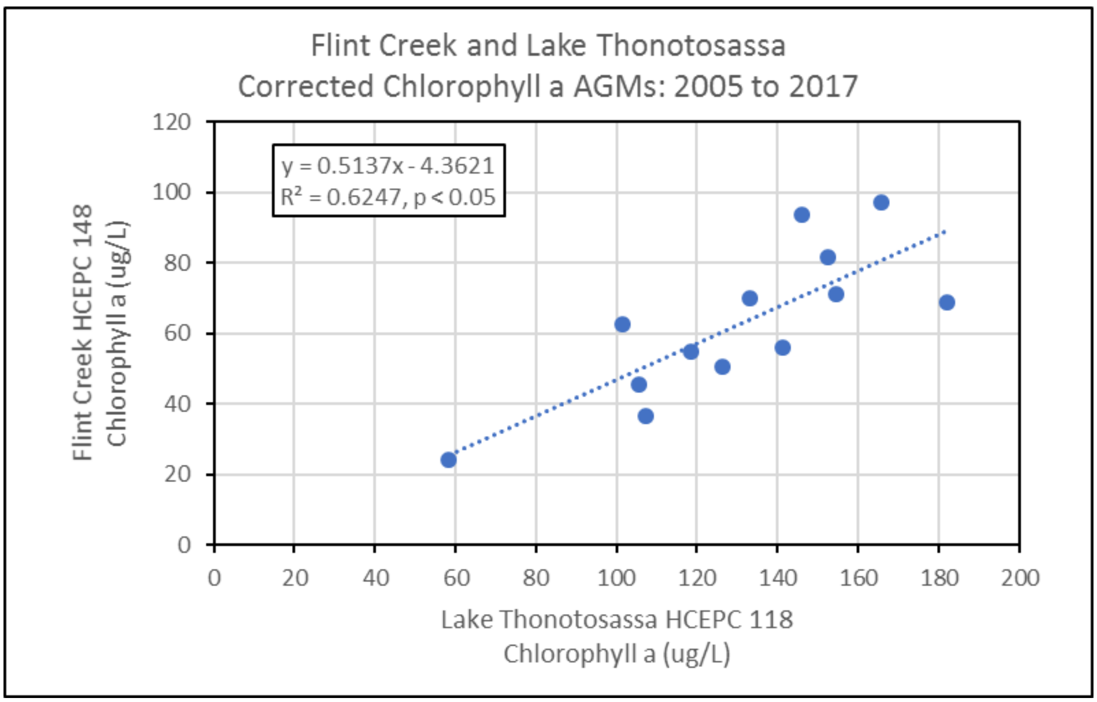

Figure 5.9. Relationship between Flint Creek and Lake Thonotosassa chlorophyll *a* AGMs

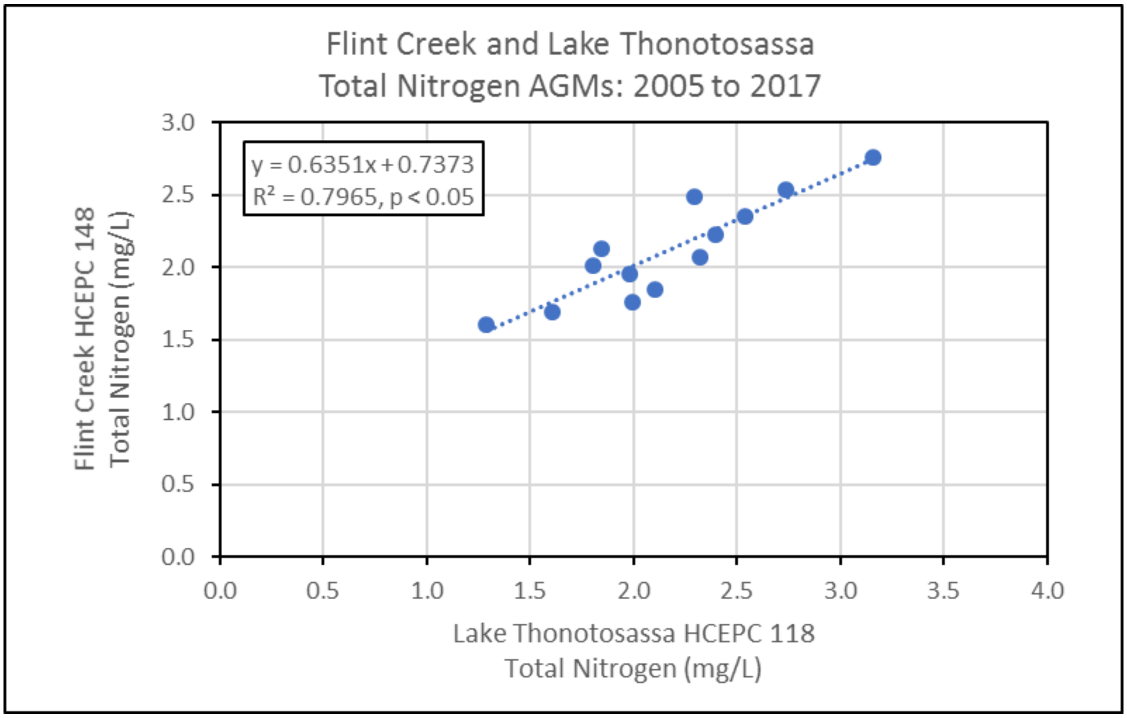

Figure 5.10. Relationship between Flint Creek and Lake Thonotosassa TN AGMs

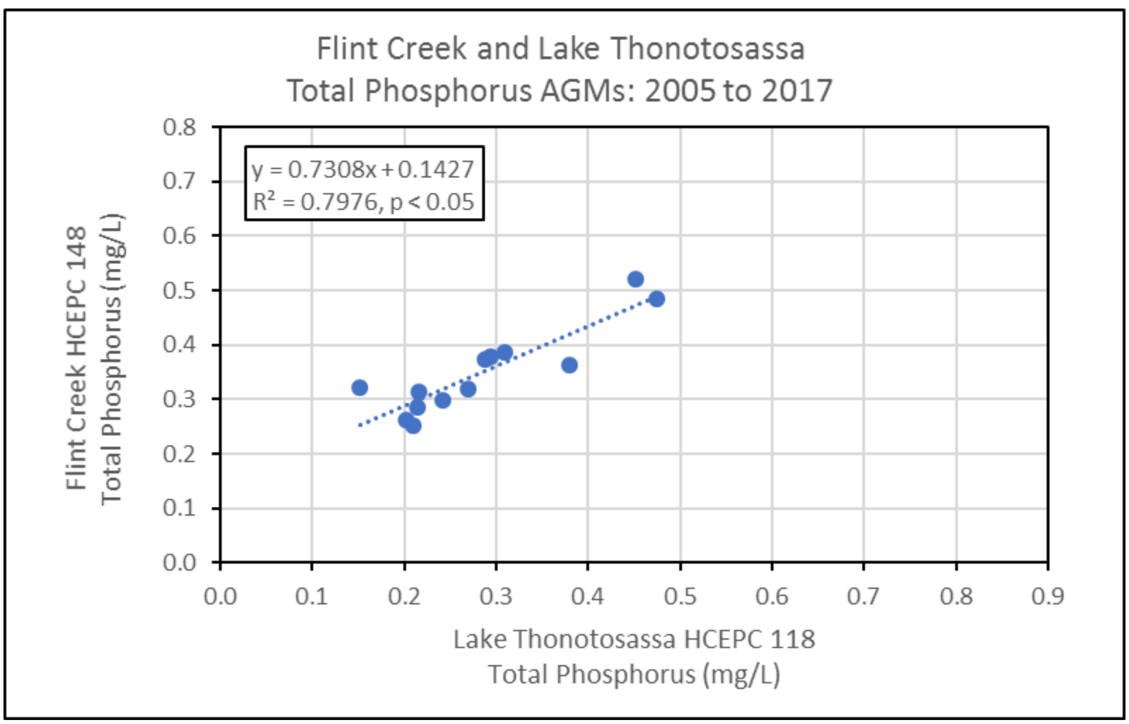

Figure 5.11. Relationship between Flint Creek and Lake Thonotosassa TP AGMs

Table 5.4. Flint Creek predicted nutrient AGMs for the Lake Thonotosassa natural loading condition

[1] Predicted values based on the relationship between the lake outlet and Flint Creek AGMs during the 2005–17 period.

Year	Flint Creek Chlorophyll *a* AGM (µg/L)[1]	Flint Creek TN AGM (mg/L)[1]	Flint Creek TP AGM (mg/L)[1]	Lake Thonotosassa Chlorophyll *a* AGM (µg/L)	Lake Thonotosassa TN AGM (mg/L)	Lake Thonotosassa TP AGM (mg/L)
1999	7	1.33	0.19	22	0.93	0.07
2000	12	1.72	0.20	31	1.55	0.08
2001	6	1.79	0.18	21	1.66	0.05
2002	2	1.58	0.17	12	1.33	0.03
2003	12	1.52	0.20	31	1.23	0.07
2004	13	1.51	0.21	33	1.22	0.10
2005	12	1.52	0.20	32	1.24	0.08
2006	14	1.71	0.21	35	1.53	0.09
2007	11	1.94	0.19	30	1.90	0.06
2008	7	1.81	0.17	22	1.69	0.03
2009	6	1.52	0.17	21	1.24	0.04
2010	8	1.61	0.18	23	1.38	0.05
80th Percentile	**12**	**1.78**	**0.20**	**32**	**1.64**	**0.08**

5.5 Calculation of the TMDLs

DEP determined that the natural background loading condition will allow the lake to achieve the site-specific chlorophyll *a* criterion and result in balanced aquatic flora and fauna communities. **Table 5.5** lists the TN and TP loads from all sources that will achieve the criterion of 32 µg/L chlorophyll *a*. The maximum 7-year average TN and TP natural background loads in the 1999 to 2010 period are selected as the nutrient loads under the TMDL condition. The TN and TP TMDLs are 46,962 and 3,137 lbs/yr, respectively. To meet the TMDL loads, the percent reductions required in the TN and TP current condition loadings (1999–2010) are 29 % and 89 %, respectively. The TMDLs established for the lake were used as the basis for developing site-specific criteria for Flint Creek to address the nutrient impairment, as described in **Section 5.4.3**.

Table 5.5. Lake Thonotosassa TMDL condition annual nutrient loads

Year	TMDL Condition TN Loads (lbs)	TMDL Condition TP Loads (lbs)	7-Year Rolling Average TN Load (lbs)	7-Year Rolling Average TP Load (lbs)
1999	50,327	3,765		
2000	35,815	2,657		
2001	29,881	1,973		
2002	35,995	2,175		
2003	63,589	3,930		
2004	93,356	6,231		
2005	19,774	1,229	46,962	3,137
2006	11,687	620	41,442	2,688
2007	32,617	1,546	40,986	2,529
2008	13,649	685	38,667	2,345
2009	50,439	2,768	40,730	2,430
2010	36,216	1,948	36,820	2,147
Maximum 7-Year Average			46,962	3,137

Chapter 6: Determination of Loading Allocations

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating loads to all the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which accounts for uncertainty in the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (1) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (2) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as "percent reduction" because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the "maximum extent practical" through the implementation of best management practices (BMPs).

This approach is consistent with federal regulations (40 Code of Federal Regulations [CFR] § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. The TMDLs for Lake Thonotosassa are expressed in terms of lbs/yr and percent reduction of TN and TP, and represent the loads of TN and TP that the waterbody can assimilate while maintaining balanced communities of aquatic flora and fauna (see **Table 6.1**). These TMDLs are based on the maximum 7-year averages of simulated data from 1999 to 2010. These allowable loads attain the site-specific numeric interpretation for chlorophyll *a* (32 µg/L, which is expressed as an AGM not to be exceeded more than once in any consecutive 3-year period). The restoration goal is to achieve the site-specific chlorophyll *a* criterion, thus protecting the lake's designated use.

Table 6.1 lists the TMDLs for the Lake Thonotosassa Watershed. The TN and TP TMDL loads (46,962 and 3,137 lbs/yr, respectively) will constitute the site-specific numeric interpretation of the narrative nutrient criterion set forth in Paragraph 62-302.530(48)(b), F.A.C., that will replace the otherwise applicable NNC for TN and TP in Subsection 62-302.531(2), F.A.C.

The Flint Creek TMDLs are expressed in terms of nutrient concentration targets for TN and TP. The creek targets are based on the expected lake water quality under the Lake Thonotosassa watershed natural background loading condition. **Table 6.2** identifies the Flint Creek TMDLs.

Table 6.1. TMDL components for nutrients in Lake Thonotosassa (WBID 1522B)

[1] The LA and TMDL daily load for TN is 129 lbs/day, and for TP is 9 lbs/day.
[2] The required percent reductions listed in this table represent the reduction from all sources.
NA = Not applicable

WBID	Parameter	TMDL (lbs/yr)[1]	WLA Wastewater (lbs/yr)	WLA NPDES Stormwater (% Reduction)	LA (% Reduction)[2]	MOS
1522B	TN	46,962	NA	29	29	Implicit
1522B	TP	3,137	NA	89	89	Implicit

Table 6.2. TMDL components for nutrients in Flint Creek (WBID 1522A)

[1] Represents the AGM creek value not to be exceeded more than once in a 3-year period.
[2] The percent reductions required to meet the creek TMDLs apply to the Lake Thonotosassa Watershed.
NA = Not applicable

WBID	Parameter	TMDL (mg/L)[1]	WLA Wastewater (% reduction)	WLA NPDES Stormwater (% reduction)[2]	LA (% reduction)[2]	MOS
1522A	TN	1.78	NA	29	29	Implicit
1522A	TP	0.20	NA	89	89	Implicit

6.2 Load Allocation

To achieve the load allocation (LA), a 29 % and 89 % reduction in current TN and TP loads, respectively, will be required.

The TMDLs are based on the percent reduction in total watershed loading. However, it is not DEP's intent to abate natural conditions. It should be noted that the LA includes loading from stormwater discharges regulated by DEP and the water management districts (e.g., Environmental Resource Permits) that are not part of the NPDES stormwater program (see **Appendix A**).

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

As noted in **Chapter 4**, the City of Plant City Water Reclamation Facility (WRF), NPDES Permit Number FL0026557, can discharge reclaimed water into stormwater storage lake systems that intermittently discharge to surface waters in the Lake Thonotosassa Watershed. Until now, the facility has only transferred reclaimed water to the golf course lake systems for a one-day event to verify operation of the system. Depending on the amount of any future reclaimed water discharged to the storage lakes and the frequency of discharge from these lakes to downstream surface waters, the WRF may be required to reduce discharge to the storage lakes to meet the TMDLs.

6.3.2 NPDES Stormwater Discharges

Hillsborough County and co-permittees (FDOT District 7 and City of Plant City) are covered by one NPDES MS4 Phase I permit (FLS000006). Areas within their jurisdiction in the watershed are responsible for a 29 % reduction in TN and an 89 % reduction in TP from the current anthropogenic loadings.

It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety (MOS)

The MOS can either be implicitly accounted for by choosing conservative assumptions about loading or water quality response, or explicitly accounted for during the allocation of loadings. Consistent with the recommendations of the Allocation Technical Advisory Committee (DEP 2001), an implicit MOS was used in the development of these TMDLs. The MOS is a required component of a TMDL and accounts for the uncertainty about the relationship between pollutant loads and the quality of the receiving waterbody (CWA, Section 303[d][1][c]). Considerable uncertainty is usually inherent in estimating nutrient loading from nonpoint sources, as well as in predicting water quality response. The effectiveness of management activities (e.g., stormwater management plans) in reducing loading is also subject to uncertainty.

The TMDL nutrient loading and concentration targets are established by using model simulations, supported by paleolimnological analyses, that support setting the TMDLs at natural background conditions. As the TMDLs are based on natural conditions, they are inherently protective of the waterbodies.

Chapter 7: Implementation Plan Development and Beyond

7.1 Implementation Mechanisms

Following the adoption of a TMDL, implementation takes place through various measures. The implementation of TMDLs may occur through specific requirements in NPDES wastewater and MS4 permits, and, as appropriate, through local or regional water quality initiatives or basin management action plans (BMAPs).

Facilities with NPDES permits that discharge to the TMDL waterbody must respond to the permit conditions that reflect target concentrations, reductions, or wasteload allocations identified in the TMDL. NPDES permits are required for Phase I and Phase II MS4s as well as domestic and industrial wastewater facilities. MS4 Phase I permits require a permit holder to prioritize and act to address a TMDL unless management actions to achieve that particular TMDL are already defined in a BMAP. MS4 Phase II permit holders must also implement the responsibilities defined in a BMAP or other form of restoration plan (e.g., a reasonable assurance plan).

7.2 BMAPs

Information concerning the development and implementation of BMAPs is contained in Section 403.067, F.S. (the FWRA). DEP or a local entity may initiate and develop a BMAP that addresses some or all of the contributing areas to the TMDL waterbody. BMAPs are adopted by the DEP Secretary and are legally enforceable.

BMAPs describe the fair and equitable allocations of pollution reduction responsibilities to the sources in the watershed, as well as the management strategies that will be implemented to meet those responsibilities, funding strategies, mechanisms to track progress, and water quality monitoring. Local entities usually implement these strategies, such as wastewater facilities, industrial sources, agricultural producers, county and city stormwater systems, military bases, water control districts, state agencies, and individual property owners. BMAPs can also identify mechanisms to address potential pollutant loading from future growth and development. Additional information is available on DEP's BMAP website (see **Appendix D**).

7.3 Implementation Considerations for the Waterbody

In addition to addressing reductions in watershed pollutant contributions to impaired waters during the implementation phase, it may also be necessary to consider the impacts of internal sources (e.g., sediment nutrient fluxes or the presence of nitrogen-fixing cyanobacteria) and the results of any associated remediation projects on surface water quality. In the case of Lake Thonotosassa, other factors—such as sediment nutrient fluxes and nitrogen fixation—also influence the lake nutrient budgets and the growth of phytoplankton. Approaches for addressing these other factors should be included in a comprehensive management plan for the waterbody. Additionally, the current water quality and hydrologic monitoring of Lake Thonotosassa and its tributaries should continue and be expanded, as necessary, during the implementation phase to ensure that adequate information is available for tracking restoration progress.

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Appendices

Appendix A: Background Information on Federal and State Stormwater Programs

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as authorized in Chapter 403, F.S., was established as a technology-based program that relies on the implementation of BMPs designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. In 1994, DEP stormwater treatment requirements were integrated with the stormwater flood control requirements of the water management districts, along with wetland protection requirements, into the Environmental Resource Permit regulations, as authorized under Part IV of Chapter 373, F.S.

Chapter 62-40, F.A.C., also requires the state's water management districts to establish stormwater pollutant load reduction goals (PLRGs) and adopt them as part of a Surface Water Improvement and Management (SWIM) Program plan, other watershed plan, or rule. Stormwater PLRGs are a major component of the load allocation part of a TMDL. To date, they have been established for Tampa Bay, Lake Thonotosassa, the Winter Haven Chain of Lakes, the Everglades, Lake Okeechobee, and Lake Apopka.

In 1987, the U.S. Congress established Section 402(p) as part of the federal CWA Reauthorization. This section of the law amended the scope of the federal NPDES permitting program to designate certain stormwater discharges as "point sources" of pollution. The EPA promulgated regulations and began implementing the Phase I NPDES stormwater program in 1990 to address stormwater discharges associated with industrial activity, including 11 categories of industrial activity, construction activities disturbing 5 or more acres of land, and large and medium MS4s located in incorporated places and counties with populations of 100,000 or more.

However, because the master drainage systems of most local governments in Florida are physically interconnected, the EPA implemented Phase I of the MS4 permitting program on a countywide basis, which brought in all cities (incorporated areas), Chapter 298 special districts; community development districts, water control districts, and FDOT throughout the 15 counties meeting the population criteria. DEP received authorization to implement the NPDES stormwater program in 2000. The authority to administer the program is set forth in Section 403.0885, F.S.

The Phase II NPDES stormwater program, promulgated in 1999, addresses additional sources, including small MS4s and small construction activities disturbing between 1 and 5 acres, and urbanized areas serving a minimum resident population of at least 1,000 individuals. While these urban stormwater discharges are technically referred to as "point sources" for the purpose of regulation, they are still diffuse sources of pollution that cannot be easily collected and treated by a central treatment facility, as are other point sources of pollution such as domestic and industrial wastewater discharges. It should be noted that Phase I MS4 permits issued in Florida include a reopener clause that allows permit revisions to implement TMDLs when the implementation plan is formally adopted.

Appendix B: Information in Support of Site-Specific Interpretations of the Narrative Nutrient Criterion

Table B-1. Spatial extent of the numeric interpretation of the narrative nutrient criterion

Location	Description
Waterbody name	Lake Thonotosassa and Flint Creek
Waterbody type(s)	Lake Thonotosassa: freshwater lake Flint Creek: freshwater stream
WBID	Lake Thonotosassa – WBID 1522B; Flint Creek – WBID 1522A (see **Figure 2.1** of this report)
Description	Lake Thonotosassa (WBID 1522B), located in west-central Florida, covers an area of 850 acres. The lake is 1.6 miles long and 0.85 miles wide, with an average water depth of 10.5 feet and a watershed drainage area of over 56 square miles. Flint Creek (WBID 1522A), the outlet channel for the lake, is 3.0 miles long and flows to the Hillsborough River. **Chapter 1** of this report describes the Lake Thonotosassa/Flint Creek system in more detail.
Specific location (latitude/longitude or river miles)	The center of Lake Thonotosassa is located at N: 28°03'39"/ W: -82°16'42". Flint Creek is immediately downstream of Lake Thonotosassa.
Map	**Figure 1.1** shows the general location of Lake Thonotosassa and Flint Creek along with their watersheds, and **Figure 4.1** shows the land uses in the watersheds.
Classification(s)	Class III Freshwaters
Basin name (HUC 8)	Hillsborough River Basin (03100205)

Table B-2. Description of the numeric interpretation of the narrative nutrient criterion

Numeric Interpretation of Narrative Nutrient Criterion	Information on Parameters Related to Numeric Interpretation of the Narrative Nutrient Criterion
NNC summary: Generally applicable classification (if applicable) and corresponding NNC	Lake Thonotosassa is a high-color lake, and the generally applicable NNC, expressed as AGM concentrations not to be exceeded more than once in any 3-year period, are chlorophyll a of 20 µg/L, TN of 1.27 to 2.23 mg/L, and TP of 0.05 to 0.16 mg/L. Flint Creek is located in the West Central nutrient region, and the generally applicable TN and TP thresholds are 1.65 and 0.49 mg/L, respectively, not to be exceeded more than once in any 3-year period. These nutrient thresholds are part of the numeric nutrient standards for streams, which also include floral and faunal metrics. According to the NNC Implementation Document, streams with AGM chlorophyll *a* levels below 3.2 µg/L attain the chlorophyll *a* metric, while streams with AGM chlorophyll *a* levels above 20 are impaired. Streams with chlorophyll a levels between 3.2 and 20 µg/L should be compared with reference streams in the area.
Proposed TN, TP, chlorophyll a, and/or nitrate + nitrite concentrations (magnitude, duration, and frequency)	Numeric interpretations of the narrative nutrient criterion: Lake Thonotosassa: A TN load of 46,962 lbs/yr and TP load of 3,137 lbs/yr, expressed as long-term average (7-year) annual loads not to be exceeded. For assessment purposes, the long-term average annual loads will be calculated using the annual loads of the most recent 7 years in the verified period. The nutrient loads resulted in an AGM lake chlorophyll *a* of 32 µg/L, and DEP set the chlorophyll *a* criterion at 32 µg/L, expressed as an AGM concentration target not to be exceeded more than once in any consecutive 3-year period. Flint Creek: The criteria are a chlorophyll *a* AGM of 12 µg/L, TN AGM of 1.78 mg/L, and TP AGM of 0.20 mg/L, not to be exceeded more than once in any consecutive 3-year period. The targets are based on the TN and TP TMDL loads for the Lake Thonotosassa Watershed, which are representative of natural background conditions.
Period of record used to develop numeric interpretations of the narrative nutrient criterion for TN and TP	The proposed TN and TP TMDLs are based on the hydrology records from 1999 through 2010 and the SWFWMD's 2009 land use GIS information.
How the criteria developed are spatially and temporally representative of the waterbody or critical condition	Model simulations with WAM and Bathtub spanned the 1999–2010 period, which included both wet and dry years. The long-term average annual rainfall is 48.6 inches. Rainfall was below average from 1999 to 2001 and 2006 to 2008. The years 2002, 2004, and 2005 were wetter than average. **Figure 2.1** shows the locations of the sampling stations in Lake Thonotosassa and Flint Creek.

Table B-3. Summary of how designated use(s) are protected by the criterion

Designated Use Requirements	Information Related to Designated Use Requirements
History of assessment of designated use support	Lake Thonotosassa (WBID 1522B) was initially verified as impaired during the Cycle 1 assessment (verified period January 1, 1996, to June 30, 2003) for excessive nutrients because the TSI threshold of 60 was exceeded using the methodology in the IWR (Chapter 62-303, F.A.C.). As a result, the lake was included on the Cycle 1 Verified List of impaired waters for the Tampa Bay Tributaries Basin Group adopted by Secretarial Order on May 27, 2004. The Cycle 3 assessment (verified period January 1, 2007, to June 30, 2014) applied the adopted NNC for lakes, and the lake was placed on the Verified List for chlorophyll *a*, nitrogen, and phosphorus. Flint Creek (WBID 1522A) was placed on the Cycle 1 Verified List for nutrients based on exceedances of the stream chlorophyll *a* threshold of 20 µg/L. Based on the adopted NNC, the creek was verified impaired for nutrients based on chlorophyll *a* AGMs that exceeded the nutrient threshold of 20 µg/L more than once in a 3-year period.
Basis for use support	DEP evaluated a site-specific interpretation of the narrative nutrient criterion for Lake Thonotosassa based on natural background conditions using model simulation and paleolimnological study results. Lake model simulation results for natural background conditions agreed with the paleolimnological results. Based on the model simulation using the site-specific data, DEP determined a site-specific AGM chlorophyll *a* criterion, expressed as not to be exceeded more than once in a 3-year period, and long-term average nutrient loads that would attain the chlorophyll *a* criterion. When these criteria are achieved in Lake Thonotosassa, the nutrient loads entering Flint Creek will be protective of the creek's designated uses, as described in **Section 5.4.3**.
Approach used to develop criteria and how it protects uses	As noted above, the chlorophyll *a* criterion for the lake was based on natural background conditions estimated from a water quality model and paleolimnological data. The numeric interpretations of the narrative nutrient criterion for TN and TP were based on model simulations that reduced anthropogenic nutrient loads to attain the chlorophyll *a* criterion. TN and TP loads and the associated in-lake chlorophyll *a* concentrations attained by the TMDL are the site-specific interpretation of the narrative nutrient criterion. Because discharge from Lake Thonotosassa dominates conditions in Flint Creek, results from the Lake Thonotosassa TMDL model simulation were used as the basis for developing site-specific TN, TP, and chlorophyll *a* criteria for the creek to address the nutrient impairment. The creek criteria were established using empirical relationships between lake outlet and creek data.
How the TMDL analysis will ensure that nutrient-related parameters are attained to demonstrate that the TMDLs will not negatively impact other water quality criteria	Since the nutrient concentration targets are based on an ecological endpoint that is protective of both flora and fauna, other water quality criteria will not be adversely impacted and designated uses will be maintained. DEP notes that there were no impairments for dissolved oxygen (DO) in the lake. The proposed reductions in nutrient inputs will result in further improvements in water quality. The implementation of the nutrient TMDL reductions for Lake Thonotosassa to achieve the proposed criteria is expected to address the nutrient impairment in Flint Creek, since discharge from the lake dominates conditions in the creek.

Table B-4. Documentation of the means to attain and maintain water quality standards for downstream waters

Protection of Downstream Waters and Monitoring Requirements	Information Related to Protection of Downstream Waters and Monitoring Requirements
Identification of downstream waters: List receiving waters and identify technical justification for concluding downstream waters are protected	Flint Creek is the outlet for Lake Thonotosassa. The creek flows into the Hillsborough River segment identified as WBID 1443B. There are no water quality impairments in this river segment. The reductions in nutrient loads prescribed in the Lake Thonotosassa TMDLs are not expected to cause nutrient impairments downstream and will actually improve water quality in water segments farther downstream by reducing algal biomass and associated nutrients transported downstream. Furthermore, the TMDLs are based on natural background conditions, which are inherently protective of the TMDL waters and downstream waters.
Summary of existing monitoring and assessment related to the implementation of Subsection 62-302.531(4), F.A.C., and trends tests in Chapter 62-303, F.A.C.	Hillsborough County conducts routine monthly monitoring at two stations in Lake Thonotosassa and one station in Flint Creek. Other organizations (including DEP) sample these waterbodies as part of a strategic monitoring program. The frequency of sampling meets the minimum sampling requirements for future assessments, including trend tests.

Table B-5. Documentation of endangered species consideration

Administrative Requirements	Information for Administrative Requirements
Endangered species consideration	The FWS identifies the threatened West Indian manatee (*Trichechus manatus latirostris*) as a species potentially affected by activities in the area of Lake Thonotosassa and Flint Creek. However, the manatee inhabits the waters of the lower Hillsborough River downstream of the Hillsborough River Reservoir dam, which prevents the manatee from moving farther upstream. The confluence of Flint Creek and the Hillsborough River is 22 river miles upstream of the dam.

Table B-6. Documentation that administrative requirements are met

Administrative Requirements	Information for Administrative Requirements
Notice and comment notifications	A rule development public workshop was noticed on [TBD] and held on [TBD]. Public comments were received on the TMDLs during the public review period that ended on [TBD]. DEP has prepared a responsiveness summary for these comments.
Hearing requirements and adoption format used; responsiveness summary	Following the publication of the Notice of Proposed Rule, DEP will provide a 21-day challenge period and a public hearing that will be noticed no less than 45 days prior.
Official submittal to EPA for review and General Counsel certification	If DEP does not receive a rule challenge, the certification package for the rule will be prepared by the DEP program attorney. DEP will prepare the TMDLs and submittal package for the TMDLs to be considered a site-specific interpretation of the narrative nutrient criterion, and will submit these documents to the EPA.

Appendix C: Lake Thonotosassa Paleolimnological Analysis 2018

Explanation of the current short report

Sediment cores from Lake Thonotosassa were collected for diatom analyses and water-quality reconstructions in 1994, and again at the same sampling sites in November 2000 for sedimented algal and cyanobacterial pigment analyses (see Whitmore et al. 2018). Radioisotopic activities of sediment cores were obtained by gamma spectrometry (Appleby et al. 1986; Schelske et al. 1994) at the University of Florida. Total ^{210}Pb activities were determined from the 46.5 kev gamma emission peak, and unsupported ^{210}Pb activities were calculated by subtracting ^{226}Ra, as estimated from ^{214}Pb and ^{214}Bi activities, from the total ^{210}Pb activities. Sediment age/depth relationships typically are calculated using the constant rate of supply model (Appleby and Oldfield 1983). However, the sediment core from Lake Thonotosassa proved undatable because of disturbed ^{226}Ra profiles (Brenner et al. 1996). Supported levels of ^{210}Pb varied throughout the core, indicating potential inwash of sediment from the watershed to the lake, and additionally, unsupported ^{210}Pb activities did not decline in the usual manner. Rather than attempting to calculate a detailed chronology for the sediment profile, we adopted a conservative approach and assigned an age of approximately 110 yrs (4.5 half lives, c. 1884) to the 80-cm depth in both cores, the depth at which atmospheric ^{210}Pb became undetectable. This represents a reasonable time period for low-disturbance conditions in the lake, so it is informative for reference conditions in water quality. Results of diatom analyses and initial water-quality inferences were published in Brenner et al. (1996). Although the diatom-based models used in Brenner et al. (1996) were rather accurate predictors, we subsequently developed diatom-based models for water-quality inferences using weighted-averaging regression methods, which are somewhat more sensitive and generally accepted indicators, and they are consistent with contemporary methods that are used in paleolimnological studies. Sedimented pigment profiles, key changes in diatom lifeform groups, and sedimented algal and cyanobacterial profiles for Lake Thonotosassa were published in Whitmore et al. (2018). The diatom inferences represent the time period from c. 1884 to 1994, and the algal/cyanobacterial pigment profiles and N isotope values represent undated baseline conditions (from the late 1800s) to 2000.

Diatom-based statistical inferences

Past limnetic total P concentrations were inferred from diatom count data by weighted-averaging regression using log-transformed limnetic total P values for a calibration set of 69 P-limited Florida lakes (r^2 adj. = 0.88, RMSE pred. 0.188, Kenney et al. 2014, Whitmore et al. 2015) and the program C2 (Juggins 2007). Past limnetic chlorophyll *a* concentrations were inferred by weighted averaging using log-transformed limnetic chlorophyll *a* values for a calibration set of 75 Florida lakes (r^2 adj. = 0.79, RMSE pred. = 0.352, Riedinger-Whitmore et al. 2005). Past Florida 305(b) TSI (Paulic et al. 1996) values also were inferred using a calibration set of 72 Florida lakes (r^2 0.87, RMSE pred. 9.6, Riedinger-Whitmore et al. 2005).

Pigment analyses
(excerpted from Whitmore et al. 2018)

Myxoxanthophyll, oscillaxanthin, total carotenoids, and total chlorophyll pigments in each sample were extracted from 7-10 g of wet sediment using acetone. Acetone was added in 40-ml increments, and samples were shaken on a Thermo Scientific MaxQ 2000 shaker table following each acetone addition for approximately 30 minutes. Percent native chlorophyll (measured at 665 nm before and after acidification with HCl) was used to ensure that pigment preservation was suitable. Chlorophyll derivatives were estimated by measuring extracts at 665 nm (Swain 1985) using a Hitachi U-2800A UV-VIS Spectrophotometer. Subsamples for total carotenoids were saponified using a 20 % KOH/methanol mixture, extracted into petroleum ether, and measured at 448 nm. Myxoxanthophyll and oscillaxanthin were extracted using petroleum ether, then were air dried and dissolved in ethanol. Cyanobacterial pigment concentrations were determined using the trichromatic method based on absorbances at 412, 504, and 529 nm (Swain 1985). Total carotenoid, chlorophyll derivatives, oscillaxanthin, and myxoxanthophyll values were expressed per unit organic matter, which was assessed by loss on ignition (Håkanson and Jansson 1983).

Nitrogen stable isotopes
(excerpted from Whitmore et al. 2018)

Nitrogen isotopes of sedimented organic matter were measured in the Department of Geological Sciences at the University of Florida by combusting sediment samples in a Carlo Erba NA 1500 C/N/S analyzer. Combustion gases (CO_2 and N_2) were analyzed with a VG PRISM II series mass spectrometer. Stable isotope N_2 values were standardized to UF- N_2 REF, an in-house reference standard, and $\delta^{15}N$ values are expressed as per mil (‰) deviation from the atmosphere.

Results

Sedimented pigments and N isotopes
(see attached Figure 4 from Whitmore et al. 2018)
(explanation below is excerpted from Whitmore et al. 2018)

Pigment profiles from undated core 4-XI-00-12 (Fig. 4) show that chlorophyll derivatives and total carotenoids, as well as cyanobacterial pigments, increased above the 90-cm level in the core, and reached a maximum value above the 10-cm level. Delta ^{15}N values did not decrease in the core until the 20-cm level, but this is consistent with the fact that until 1970, discharges from a vegetable-processing plant, five citrus-processing plants, and 5678 m^{-3} d^{-1} of sewage effluent from a sewage-treatment facility entered the lake (Cowell et al. 1975), which would have sustained delta ^{15}N values at enriched levels. The rapid decrease in delta ^{15}N values above the 20-cm level is consistent with cyanobacterial presence.

Diatom-based water-quality inferences

Table 1 indicates that limnetic total P at the time of deposition of the base of the core was approximately 46 µg/L, limnetic chlorophyll *a* (uncorrected for pheophytin) was approximately 29 µg/L, and Florida 305(b) TSI was approximately 62.

We are aware that Lake Thonotosassa has been subject to excessive nutrient loading (Cowell et al. 1975), and that limnetic total P in the lake during 1985–1994 ranged as high as 320-1100 µg/L (Brenner et al. 1996). It is quite evident that total P and chlorophyll *a* values in recent decades far exceed water-quality conditions in the calibration sets used for diatom-based inferences, so values above the ~56-cm level should not be expected to be reliable. However, diatom assemblages and inferences at the base of the core are well centered in the calibration set, and they should be reliable within the performance expectations of the models.

Table 1. Diatom-based water-quality inferences

Sediment Depth (cm)	Limnetic Total Phosphorus (µg/L)	Limnetic Chlorophyll *a* (µg/L)	Florida 305(b) TSI
0	90.65	73.55	74.86
8	111.42	78.70	76.37
16	106.47	76.29	75.94
24	89.85	65.57	73.25
32	95.29	79.85	75.55
48	82.32	71.39	73.53
56	55.09	57.73	69.56
64	56.39	36.87	64.42
72	54.64	36.73	63.86
80	52.96	29.92	61.53
88	45.78	29.34	61.60

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Whitmore et al. 2018, Figure 4

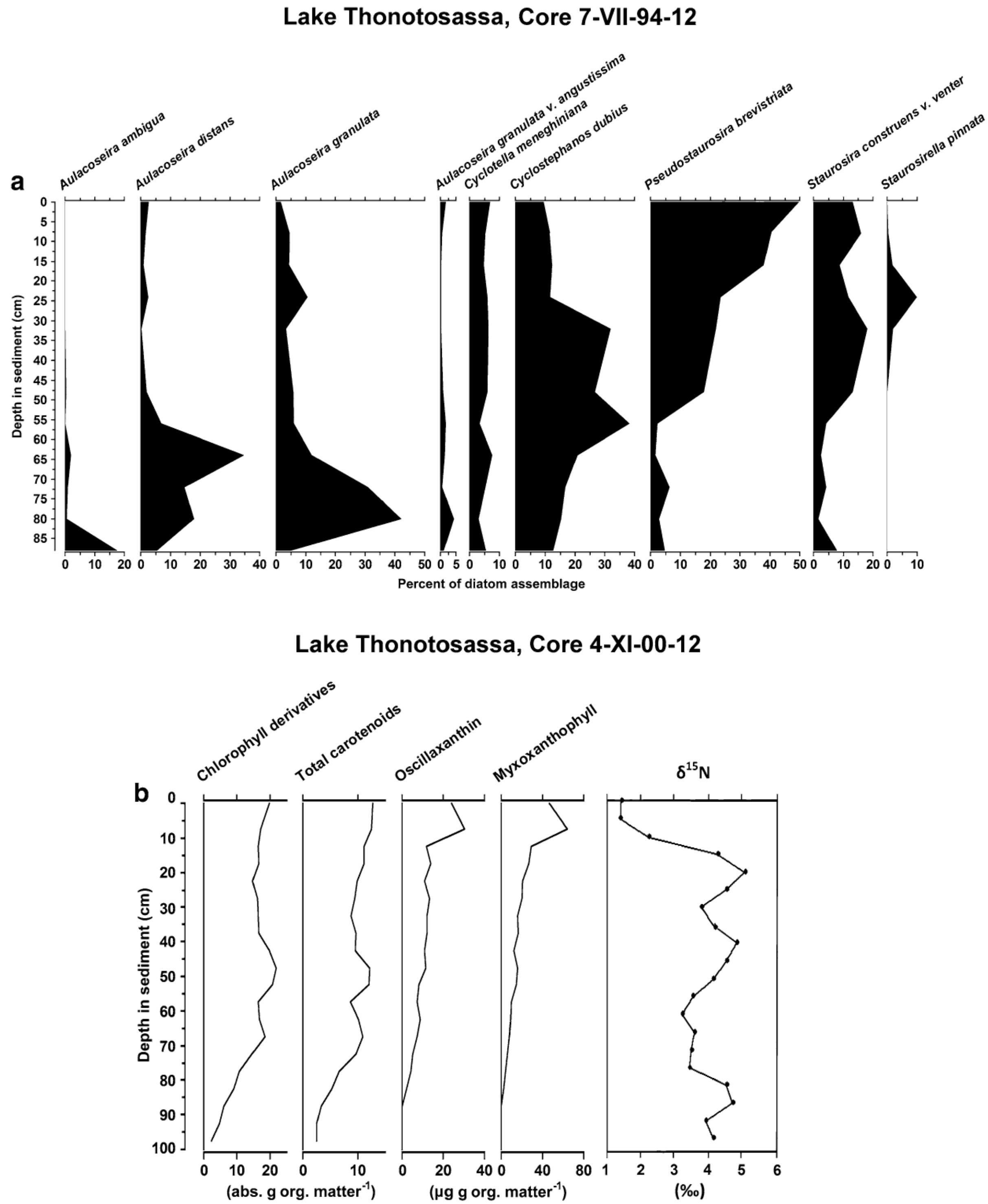

Fig. 4 Lake Thonotosassa sediment cores; **a** percentage plots of *Aulacoseira* spp. and fragilarioid taxa (modified from Brenner et al. 1996); **b** sedimented algal and cyanobacterial pigments; and $\delta^{15}N$ values of sedimented organic matter

Appendix D: Important Links

DEP website: https://floridadep.gov/
DEP TMDL Program: https://floridadep.gov/dear/water-quality-evaluation-tmdl/content/total-maximum-daily-loads-tmdl-program
DEP IWR: https://www.flrules.org/gateway/ChapterHome.asp?Chapter=62-303
DEP Florida WIN/STORET Program: https://floridadep.gov/dear/watershed-services/content/winstoret
DEP 2018 Integrated Report: https://floridadep.gov/dear/bioassessment/documents/integrated-303d305b-report-2018
Florida Surface Water Quality Standards:
https://www.flrules.org/gateway/ChapterHome.asp?Chapter=62-302
DEP BMAPs: https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps
EPA Region 4, TMDLs in Florida:
https://archive.epa.gov/pesticides/region4/water/tmdl/web/html/index-2.html
EPA National STORET Program: https://www.epa.gov/waterdata/storage-and-retrieval-and-water-quality-exchange
FWS Information for Planning and Conservation (IPaC) tool: https://www.fws.gov/ipac/